REPORT ON FUEL TESTS
AND
THE ISSUE OF FUEL

1914

WAR DEPARTMENT : OFFICE OF THE QUARTERMASTER GENERAL

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The following Report on Fuel Tests and the Issue of Fuel, made under the direction of the Quartermaster General of the Army by Capt. Frank T. Hines, Quartermaster Corps, is approved and herewith published for the information and guidance of all concerned.

By order of the Secretary of War:

W. W. Wotherspoon,
Major General, Chief of Staff.

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REPORT ON FUEL TESTS AND THE ISSUE OF FUEL.

War Department,
Office of the Chief of the Quartermaster Corps,
Washington, April 28, 1914.

From: Capt. Frank T. Hines, Quartermaster Corps.
To: The Chief of the Quartermaster Corps.
Subject: Fuel.

1. There is submitted herewith for your consideration a full and detailed discussion of the subject of the issue of fuel to the Army at large.

2. This subject has been given careful consideration and is presented herein under the following headings:

First. The issue of fuel to troops at military posts and stations.

Second. The issue of fuel to officers and enlisted men at military posts and stations, when occupying public buildings as quarters.

Third. The fuel allowances of officers and enlisted men when serving with or without troops at stations where no public quarters are available.

FIRST. THE ISSUE OF FUEL TO TROOPS AT MILITARY POSTS AND STATIONS.

The present allowances of fuel are prescribed in Army Regulations, 1044, 1913, and from time to time many interpretations have been made by this office relative to the issue of fuel as fixed by that regulation, taken in connection with the extra issues thereof, which may be authorized under paragraph 1006, Army Regulations, 1913. It will be noted that the allowances prescribed in the paragraph referred to are based on the number of men occupying the buildings in question and on the latitude, the allowances being computed from the allowance as given in cords of wood.

As generally understood, the quantities stated in the table included in paragraph 1044, Army Regulations, 1913, are the maximum allowances of fuel for enlisted men occupying barracks or quarters when said barracks or quarters are heated with heating stoves, and the allowances as therein stated include the fuel required for cooking, heating water, etc., there being no definite allowance for cooking and heating water.

When it is found that the allowances of fuel as fixed by this table are not sufficient to heat the barracks, quarters, or other buildings

occupied as such, and do the cooking, heat the necessary water for bathing and other purposes (the number of heating stoves not exceeding the number fixed in the table), the additional fuel required is an extra issue within the meaning of paragraph 1006, Army Regulations, and final action thereon is taken by the department commander.

In cases where it is found necessary to make use of heating stoves in excess of the allowance authorized in the paragraph referred to, which increase would cause the use of extra fuel, the issue thereof requires the approval of this office.

The allowances of fuel where buildings are heated by steam or hot-water heating plants is a separate and distinct allowance from that fixed by the table in Army Regulations, 1044, and takes the place of all other allowances for the enlisted men occupying the buildings so heated.

These allowances are found in the last paragraph of Army Regulations, 1044.

Where a building is heated by steam or hot-water plant and the quantity of coal authorized, based on radiating surface, is not sufficient to properly heat the building, any additional quantity of fuel necessary is also considered an extra issue and requires authorization under the provisions of Army Regulations, 1006, final action thereon being taken by the department authorities and subsequently reported to this office.

From what has preceded, therefore, it will be seen that the fuel necessary for preparing food and heating water for enlisted men in barracks or quarters is an extra issue, which is recommended by the post authorities and authorized by the department authorities. The present instructions of this office require post quartermasters to submit promptly at the end of each month to department quartermasters a report of the quantity and kind of coal used in excess of the allowances fixed by regulations, which report is submitted for the approval of the department commander, in accordance with Army Regulations, 1006.

It is evident from the number of interpretations requested of Army Regulations, 1044, that the provisions relative to the issue of fuel and the requirements of the regulations are not clearly understood, and it is doubtful if such provisions are strictly complied with at military posts.

An investigation of the matter indicates that extra issues of fuel have been made for cooking and for heating water for bathing purposes at nearly every post situated above the thirty-sixth degree of north latitude. These reports are made monthly, and as the amount of coal necessary for these purposes is very large it would indicate that the regulation allowance for heating is insufficient to include the

necessary amount of fuel needed for heating water and for cooking purposes as well.

In the opinion of this office, as it is always necessary to make these extra issues, it would appear to be a saving of time, work, and correspondence and, no doubt, an economy in the use of fuel if the allowances for all purposes were definitely fixed.

The heating plants and ranges used at military posts are very costly and by neglect and misuse they are often put out of service or costly repairs are made necessary in a year's use or less, when it is thought that by proper care and handling their life should be prolonged to 12 or 15 years, and, in some instances, longer, with only an occasional small outlay for repairs.

The damage done is due, first, to too intense firing, which warps and burns out range tops and ovens and melts linings of fire doors; second, from allowing ashes to accumulate in ash pits until grates, for the want of proper air supply, are burned and melted; third, from want of air through slides of feed doors the heat burns and melts linings of feed doors; fourth, from the excessive use of coal and the filling of the fire boxes to their utmost capacity, with the drafts fully opened and all door ventilators closed. This warps and cracks boiler fronts, burns out fire boxes, and forces leaks in water tubes and sections; fifth, neglect to regulate back check drafts.

From reports that have been received from time to time in this office in regard to the use of fuel for heating and cooking, it is clearly indicated that at a large number of posts the amount of fuel actually used for these purposes is from 10 to 20 per cent in excess of the amount that should be required for the proper heating of the several buildings and for cooking.

Considerable data has been collected relative to this matter, and, after a careful study, a plan has been worked out which seems to offer a proper solution of the fuel problem. With the approval of the Secretary of War, on January 22, 1914, and with a view to definitely determining whether such a plan could be operated practically at Army posts, fuel tests were conducted from February 14 to March 25, 1914, at Fort Myer, Va., Washington Barracks, D. C., and Fort Sheridan, Ill. The results of these tests clearly indicate that the plan proposed, which follows, is entirely feasible and will result in greater economy in the use of fuel and in the annual upkeep of heating plants; also, in many instances, it will result in greater comfort to officers and enlisted men occupying public buildings at military posts.

The methods used in conducting the tests at the posts above referred to and the results obtained are hereto appended and marked "Exhibit —." A careful study of the methods used and results

obtained would seem to indicate that the following plan should be put into effect at all military posts at the earliest practicable date:

First. To require the post quartermaster to keep a definite and accurate account of the amount of fuel of all kinds that is received and issued to each of the several buildings at an Army post. With a view of assisting the post authorities in the receiving, issuing, and supervising the use of fuel at Army posts, a noncommissioned officer of suitable grade, Quartermaster Corps, to be designated, whose duties will be to receive and supervise the issue and use of fuel in all buildings at that post.

Second. That there be assigned to each public building or group of buildings, a competent enlisted man for the purpose of handling the heating apparatus installed in that building or group of buildings. In the case of company or detachment barracks, a company fireman should be required to keep a daily record of the amount of coal used and the temperature of the squad rooms in such building. The man so assigned in charge of the heating apparatus should be changed as infrequently as possible, and should be selected because of his trustworthiness and special fitness for the work. The organization commander or officer responsible for the building in question should be required to make an inspection of the heating apparatus installed in that building, and, in the case of company or detachment barracks, some responsible noncommissioned officer of the organization should be required to supervise daily the important matter of proper and economical use of fuel, the daily removal of ashes from ash pits, and the cleaning of flues. Greater interest and economy in the use of fuel will be obtained when the company firemen are required to keep a daily record of the amount of coal used and the temperature of the squad rooms in each building, and at the time of periodical inspections prescribed in existing regulations, both by company and post commanders, if these matters are inquired into, competition and interest will be much stimulated.

Third. An accurate and definite account of the amount of fuel of all kinds issued to a building will be kept by the noncommissioned officer, Quartermaster Corps, furnished to each post to assist the post authorities in this matter. This account will be checked frequently, and the instant any building appears to have drawn more fuel than allowed by the fuel charts for the proper and economical firing of the apparatus in such building, a report will be made to the post commander, with a view to having the matter investigated and definitely determining the reason for such apparent excessive use of fuel.

Fourth. The noncommissioned officer, Quartermaster Corps, designated to supervise the use of fuel at military posts, will be re-

quired to make periodical (daily, if possible) inspections of heating plants and other apparatus for which fuel is issued at a military post, to see that they are properly fired and that the instructions relative to their use are being complied with.

Fifth. For the firing of heating boilers in officers' quarters and messes at a military post there should be assigned a detail of a sufficient number of enlisted men from organizations serving at the post, to properly take care of such heating apparatus. This detachment should be in charge of a noncommissioned officer of suitable rank, who will be responsible for the proper use of fuel in such buildings.

3. The post authorities can not give this subject too close attention, and it is believed to be perhaps the most serious waste in post administration, as the reports received and the results of tests made indicate that the cost of upkeep of the apparatus referred to is excessive.

4. As previously stated, the present allowances of fuel for barracks and public buildings are based on the number of men occupying such buildings and the latitude. A study of the temperature charts submitted with this report clearly indicates that these premises are not well founded and that the issue of fuel, for any purpose, is necessarily dependent upon the following:

First. The building.

Second. The heating apparatus installed in the building.

Third. Mean minimum temperature of the locality in which the building is situated.

5. It is therefore believed that the issue of fuel at military posts and stations should be based—

First. Upon the area in square feet of grate on which the fuel is burned.

Second. The average outside temperature during the time such fuel is burned.

Third. On a factor which takes into account the human element, or those charged with the operation of such apparatus.

6. To attempt to introduce a fourth variable, i. e., the number of men in the heated buildings, is entirely impracticable. The basic facts, as stated above, are easily determined, as the area of any given grate is constant, reliable temperature records for a period of from 30 to 40 years are available, and the results obtained in practical tests in connection with the method outlined are known.

7. It then becomes necessary to make only one assumption: The maximum rate at which coal can be economically burned, with natural draft, under heating boilers. Past experience of this office and the results obtained in connection with the fuel tests above referred

to both indicate that this rate is approximately 5 pounds per square foot for grates up to 7 square feet in area and about 6 pounds per square foot for grates from 7 to 16 square feet in area. Reference to the curves showing results of the tests conducted at Washington Barracks and Fort Myer clearly indicates that with these amounts of coal for the square feet of grate area referred to, there will be sufficient allowance to take care of the variable factor caused by those charged with the operation of such apparatus, and at no post in the temperature zones referred to should the fuel consumption exceed that given on the charts.

8. With the data determined, coal consumption charts for various minimum temperatures from plus 40° to minus 40°, at 10° intervals, have been prepared, and the allowable rate of combustion at any intermediate (average temperature) between 70° and the minimum on any chart is directly interpolated.

9. In addition to the above charts, for any one post it is only necessary to have a record of the average temperature for the heating season to obtain the coal consumption in any boiler, either for the entire season or for any one or more months of the season.

10. There are appended hereto two sets of blue prints, the first set being a tabulation of temperatures from which a mean temperature for each post has been determined; also temperature curves which have been prepared by the Weather Bureau in connection with the tests above referred to. Each chart shows the name of the post to which it is applicable, the mean temperatures for the various localities, which were obtained from the Weather Bureau, being based on reports for a number of years, varying from 30 to 40 years; and, second, a set of blue prints, numbered from 1 to 9, have been prepared showing the allowable coal consumption per square foot of grate area at the several posts for steam and hot-water boilers.

11. To illustrate how this method of the issue of fuel may be carried out, the following example is given: Referring to chart No. 5, herewith, on which chart appears, among other posts named, Fort Myer, Va., and which post may be taken as an example, the problem would be solved in this manner, assuming the building in question to be equipped with a Century boiler of 2,200 feet capacity, with $10\frac{1}{2}$ square feet of grate area:

First. To determine the amount of coal necessary for a heating season of eight months:

(*a*) Referring to temperature table herewith, it will be found that the average temperature for Fort Myer for the season is 45° F.

(*b*) Interpolating on the coal chart at 45° it will be found that 2.15 pounds of coal should be required per square foot of grate area

per hour as the average rate of combustion, so that the total tons of coal for a heating season of eight months would be as follows:

$$\frac{2.15 \text{ pounds} \times 24 \text{ hours} \times 242 \text{ days} \times 10.5 \text{ square feet}}{2{,}240 \text{ pounds.}} = 60 \text{ tons for the season.}$$

12. It is believed from data obtained in the fuel test at this post that an amount of fuel nearer to fulfilling actual conditions can be ascertained by computing in accordance with the preceding method for each month of the year, rather than for the entire heating season. This amount would then be determined for each month as follows, assuming the month of January:

(*a*) Referring to temperature table, it will be found that the average temperature for the month of January is 35°.

(*b*) Interpolating on the coal charts at 35°, it will be found that 3 pounds of coal per square foot of grate area is the proper amount to be used for the boiler in question. The total allowance by this method would then be determined as follows:

$$\frac{3 \text{ pounds} \times 24 \text{ hours} \times 31 \text{ days} \times 10.5 \text{ square feet}}{2{,}240 \text{ pounds.}} = 10.45 \text{ tons for the month of January.}$$

13. The above calculations are based on the assumption that standard coal of 1,800 pounds equivalent per cord of oak wood is used. This may not be the case at other posts, and if coal which has a different fuel equivalent is used, it will be necessary to apply a correction for this difference of equivalents. This problem would be worked out as follows:

In the case of the amount determined for the month of January, which, it will be seen, was 10.45 tons for a coal having an equivalent of 1,800 pounds per cord of oak wood, assuming that instead of it being the standard coal of 1,800 pounds per cord of oak wood, a coal having equivalent of 1,675 pounds was used, the correct allowance would then be: $\frac{1{,}675}{1{,}800} \times 10.45 = 9.67$ tons as the correct allowance for the month of January.

14. It will readily be seen that for each building in question the post quartermaster would work out the allowance for each month and tabulate it for ready reference. Should the amount of coal issued to the building be exceeded at any time during the period in question, it will clearly indicate that those in charge of the heating apparatus are not obtaining the best results in the use of such apparatus, and that the fuel in question is not being economically burned. In addition to the heating boilers installed in barracks, there are also installed hot-water heaters, for which a definite allowance of fuel should be given. The allowance for the Tabasco hot-water heater,

or in fact for any hot-water heater installed, can be readily determined in a manner similar to that given above. From the charts attached hereto the allowances have been computed and are given in the following table, and apply to the Tabasco hot-water heaters in the service:

	Heater.			
	No. 150, 17 and 18.	No. 200, 21 and 22.	No. 300, 25, 26, and 27.	No. 500, 30.
Grate areas, square feet	[1] 0.7854	0.7855–1.40	1.41–2.18	2.19–3.40
Coal allowance, in pounds per month	3,000	4,000	7,000	9,000

[1] And less.

The above quantities are based on the mean outside temperature found during tests at Washington Barracks and Fort Myer, Va. While the temperature has a material bearing on the quantity of fuel used for heating, the variation, so far as the heating of water is concerned, is very slight, and no additional allowance should be made therefor. Slight variation in temperature being considered in arriving at the above quantities.

These allowances are based on the assumption that anthracite and good coking bituminous coals are used. Should any other coal be used, corrections of the amounts above indicated should be made in accordance with paragraph 13 above, the same formula being applicable.

15. In addition to the heating boilers and Tabasco heaters, there are also used in barracks and other buildings occupied by troops Army ranges for cooking purposes. From the results obtained from data received in this office from time to time and that obtained at the recent tests, it was found that the several types of ranges average in the use of fuel as follows:

No. 3 range, 84.45 pounds per day, or 2,533.5 pounds per month.
No. 3a range, used in noncommissioned officers' quarters, 1,744.5 pounds per month.
No. 4 range, 203.3 pounds per day, or 6,099 pounds per month.
No. 5 range, single, 159 pounds per day, or 4,770 pounds per month.
The Latrobe heater in noncommissioned officers' quarters, size 0.78 square foot grate, used 1,634.3 pounds per month.
Latrobe, size 0.99 square foot of grate, 1,801.8 pounds per month.

It is therefore recommended that the allowances for Army ranges be fixed as follows:

Army ranges:
Nos. 1, 2, 6 (old), 3, 3a, not exceeding 2,500 pounds per month.
Nos. 4a (old) and 5 single, 4,500 pounds per month.
Nos. 4 (old) and 5 double, 6,000 pounds per month.

The tests show that the outside temperature and the time of year cause the amount of fuel used for cooking purposes to vary slightly.

This is especially so in case of ranges used in officers and enlisted men's quarters, where the kitchen range heats the kitchen. So that necessarily in cold weather the amount of fuel required for officers and enlisted men's quarters, so far as cooking and heating water are concerned, is increased. The amounts above fixed, however, will prove ample and answer all purposes for the year round.

16. These allowances are based on the assumption that anthracite and good coking bituminous coals are used. For any other type of fuel the formula given in paragraph 13 should be used to determine the amount of fuel needed. Reference to the charts attached to this report, showing the results of the fuel tests at Fort Myer, Va., and Washington Barracks, D. C., clearly indicates that the allowances as given above are ample, and for that reason the post authorities should be required to keep within these allowances. Any fuel used in addition to the above to be charged against the officer responsible for the building in which such apparatus is used.

17. For the benefit of those charged with the calculations to determine the amount of fuel allowances for the apparatus installed in buildings occupied by troops, there is attached to this report a statement giving the grate areas for the several heating boilers purchased and installed in buildings under the Quartermaster Corps.

SECOND. THE ISSUE OF FUEL TO OFFICERS AND ENLISTED MEN AT MILITARY POSTS AND STATIONS WHEN OCCUPYING AS QUARTERS PUBLIC BUILDINGS.

1. The act of March 2, 1907, authorizes the furnishing of the heat and light "when actually necessary for the authorized allowance of quarters for officers and enlisted men," and further provides that such heat and light shall be furnished "under such regulations as the Secretary of War may prescribe." In accordance with the above act, the fuel allowances for officers and enlisted men entitled to and occupying public quarters are prescribed in Army Regulations, 1036, taken in connection with Army Regulations, 1044, 1913.

2. It will be noted that these allowances are based upon the number of rooms to which the officer or enlisted man is entitled and the degree of latitude in which such officer or enlisted man is serving. The table of allowances is given in cords of oak wood per month.

3. The allowances are accumulative within a fiscal year, and any excess of allowances appearing overdrawn by an officer or enlisted man at the end of a fiscal year is to be paid for at the contract price of the fuel in question.

4. The purposes for which fuel is issued to officers or enlisted men at a military post may be stated as follows:

First. For the heating of the quarters assigned to such officers or enlisted men.

Second. For cooking and heating water in the quarters to which assigned.

5. At a military post officers may find themselves occupying quarters under various conditions, which ordinarily will fall under one of the following headings:

(*a*) Occupying public quarters at a military post consisting of a greater number of rooms than that authorized by Army Regulations.

(*b*) Occupying public quarters at a military post consisting of a less number of rooms than authorized by Army Regulations.

(*c*) Occupying public quarters at a military post of the actual Regulation allowance of rooms.

6. The allowance and assignment of quarters is governed by Army Regulations, 1024 to 1035, and the conditions enumerated above are not always within the control of the officer in question. While it is true that officers, under the regulations referred to, are given the right to select quarters in accordance with their rank, conditions usually exist at posts which prevent them from selecting quarters containing their regulation allowance of rooms, so that it can be definitely stated that the last condition named above—that of occupying public quarters at a military post of the regulation allowance of rooms—is a condition which seldom, if ever, exists, except in the case of a second lieutenant living in bachelor quarters. It is this fact alone which is undoubtedly responsible for the present difficulties relative to the allowances of fuel, and it will readily be understood that the two conditions of an officer occupying at a military station generally a greater number of rooms than his rank entitles him to, and the fact that the allowances of fuel are fixed definitely on the number of rooms in accordance with such rank, make it doubtful if these two conditions can ever be reconciled.

7. As a matter of fact, the officer, as a rule, has little choice in determining in which of the three conditions of occupancy referred to above he may find himself at a military post, and it is believed safe to assume that Congress in establishing a limit of cost of officers' quarters at a military post never contemplated that quarters of one, two, three, or even four rooms would be constructed. The fact that they fixed this limit of cost for general, field, and line officers' quarters would seem to indicate that it was contemplated that quarters for officers falling in the three classes would be for each of the classes named of approximately the same size and with equal conveniences, and accordingly quarters have been constructed within the limits of cost prescribed by Congress.

8. The basis of allowances on the number of rooms to which an officer is entitled was established more with a view of establishing a monetary value for these allowances when the officer passed from

service at a military post, or where these allowances could be furnished in kind to the commutation status, or where the allowances could not, as a rule, be furnished in kind.

9. The connecting up, therefore, of the fuel allowances to the number of rooms undoubtedly has established a wrong premise in respect to the issue of fuel in kind and the commutation value thereof.

10. As previously stated in connection with the issue of fuel at military posts to troops, it is believed that the controlling features relative to the issue of fuel to officers and enlisted men are, first, the building to which the officer or enlisted man is assigned; second, the heating apparatus installed in such building; third, the mean minimum temperature of the locality in which the building is situated.

11. The character of the building to which the officer or enlisted man is assigned is known; the proper amount of radiating surface or the proper type of heating apparatus is installed in such building, based upon the character and kind of building used. Therefore, this factor is definitely known. The heating apparatus installed in the building is of a type which is also known and the amount of fuel which should economically be used in such heating apparatus can be readily determined.

12. The mean minimum temperatures of the several localities in which military posts are located have been determined from data collected for the past 30 to 40 years by the Weather Bureau.

13. In view of these facts, it would seem reasonable to assume that the allowance of fuel for officers and enlisted men serving at military posts and stations and occupying public quarters should be established upon one of the following bases:

(*a*) That fuel should be issued in kind for the building concerned and not for any particular occupant of such building; that the allowance for this building should be determined from the heating apparatus installed in said building, i. e., in accordance with the square feet of grate area and the temperature zone in which the building is located.

(*b*) Or that the fuel allowance for officers and enlisted men be computed and that they be given a definite monetary allowance for such purposes and be required to purchase the necessary amount of fuel from the Government at contract price for heating the quarters occupied by them at military posts, as well as for cooking and heating water for other purposes.

These two methods have been considered and are presented herewith separately.

FIRST METHOD. ISSUE OF FUEL IN KIND TO BUILDINGS.

This method has the advantage that the actual amount of fuel necessary will be issued and any savings in the amount of fuel given as the allowance for the building in question will revert to the Gov-

ernment. The amount allowed for the building being based upon the economical use of fuel in the apparatus installed in such building, and the temperature will at all times be sufficient to afford proper heating for the quarters in question. At the same time any excess use of fuel above the allowance will be charged against the occupant of the building in question. This method, it is thought, also requires the least amount of work in connection with the accounting for the fuel issued for the buildings concerned.

Reference to the chart attached hereto, entitled "Comparison of daily allowances of fuel based on proposed new chart allowances and Army Regulations," indicates that a material saving in the amount of fuel will be effected by the issue of fuel in kind to buildings at a military post in accordance with the method herein outlined. It frequently occurs at a military post that an officer of high rank is assigned to a building wherein the heating apparatus will probably require the fuel allowance of an officer of junior grade. Likewise, in the case of bachelor quarters, the necessary amount of fuel for heating such building depends upon the heating apparatus, the building, and the outside temperature, whereas the total allowance under the present regulations would be the combined allowances of the officers concerned, which would manifestly be greatly in excess of the necessary amount of fuel that could economically be burned in the apparatus installed in such building.

SECOND METHOD. GIVING TO EACH OFFICER A MONEY ALLOWANCE FOR FUEL.

It would be difficult under this method to arrive at a money allowance that would fulfill all conditions in all parts of the country. It would probably be necessary to have several allowances in order to assure proper allowance being given to officers in the different localities in which serving. This would undoubtedly result in complications in having more than one allowance for each grade.

As previously stated, officers are frequently assigned at military posts to houses with more than their regulation allowance of rooms. The money allowance, if based upon their allowance of rooms, would not, in all cases, be sufficient to purchase enough fuel to properly heat a house of a greater number of rooms than their allowance to which they might be assigned.

Principally for the reasons given in first method above, and the fact that any money allowance made for such purpose would necessarily have to be sufficiently large to enable an officer to properly heat a building of a greater number of rooms than his authorized allowance, it is not believed to the best interests of the service that this method be placed into effect, and it is doubtful whether such method could properly be carried out without congressional action.

THIRD. FUEL ALLOWANCES OF OFFICERS OR ENLISTED MEN WHEN SERVING (OTHER THAN AT MILITARY POSTS) WITH OR WITHOUT TROOPS AT STATIONS WHERE NO PUBLIC QUARTERS ARE AVAILABLE.

1. When officers or enlisted men are assigned to duty, with or without troops, at a station other than a military post, under the present regulations fuel is either issued in kind under Army Regulations, 1036, taken in connection with Army Regulations, 1044, 1913, or in cases where such officer or enlisted man is occupying quarters other than public, heated by a separate plant, for which it is impracticable to furnish fuel in kind, the present regulations require this corps to pay the owner or authorized agent of such quarters for the heat at the rate of $4 a cord for the fuel allowance for the number of rooms actually occupied, but not exceeding the number authorized by regulations.

2. When an officer or enlisted man leaves a military post under the conditions above stated, he assumes one of the following conditions of occupancy of quarters:

(*a*) In a dwelling house provided with a separate heating plant and appliances for cooking.

(*b*) In an apartment, hotel, or club not provided with a separate heating plant or separate appliances for cooking.

(*c*) In an apartment without a separate heating plant or cooking facilities.

(*d*) The joint occupancy with others in any of the places above referred to.

3. Under each of the conditions named, the officer or enlisted man concerned may—

First. Occupy a greater number of rooms than authorized in Army Regulations.

Second. He may occupy a less number of rooms than authorized in Army Regulations.

Third. He may occupy the regulation allowance of rooms.

In other words, there are four entirely different methods of living, with three modifications of each, or no less than 12 different conditions to be considered under the existing regulations regarding the issue of fuel.

4. It is manifest, therefore, from the start that it is not practicable, and, it might be stated, next to impossible, to arrive at an allowance which will meet all the conditions above named exactly. It would seem reasonable, therefore, that the proper thing to do in connection with the solution of this problem would be to arrive at an allowance which would come the nearest to satisfying all conditions, the reasonableness of which can not be questioned.

5. In the first case referred to, i. e., where an officer or noncommissioned officer occupies a dwelling house, under the present regu-

lations, fuel in kind is issued for heating and cooking purposes, and the maximum allowances therefor are provided in Army Regulations, 1044.

In this case, only the actual amount of fuel necessary for these purposes is furnished to the officer in kind, and any saving resulting from the allowances provided in Army Regulations, 1044, revert to the Government. In case the amount of fuel necessary for these purposes is exceeded, the officer must necessarily purchase the additional fuel needed at his own expense.

6. In the case of an apartment, hotel, or club, not provided with a separate heating plant or with separate appliances for cooking, it has heretofore been considered impracticable to determine definitely the amount of fuel actually necessary for the particular apartment in question, and, in accordance with the regulations above referred to, the full commuted value of the fuel allowance for the grade of the officer in question has been paid to the owner of the apartment, hotel, or club.

7. Two conditions may arise in the case of an officer occupying an apartment, hotel, or club—one, when the apartment, hotel, or club is provided with separate appliances for cooking, and the other, where no such appliances are available. In the first case, any fuel used for cooking, in view of the fact that the full commuted value of the officer's fuel allowance has been turned over to the owner of the apartment, hotel, or club, must necessarily be paid for by the officer himself.

The full commuted value turned over to the landlord in this case must include the amount necessary for heating and the proportionable amount necessary for cooking and heating water. In other words, the rate given an officer in an apartment, hotel, or club includes all the conveniences attached to such quarters, and a separation of the amounts for rent, heating of the apartment, and heating of water is not practicable.

8. In an apartment without a separate heating plant or cooking facilities, the commuted value of the fuel turned over to the landlord is in payment for the necessary heating of the apartment and the heating of water only, and in lieu of the necessary cooking facilities the officer must make arrangements elsewhere for these conveniences.

9. In the case of joint occupancy under any of the conditions enumerated above, greater difficulties are involved in order definitely to determine the quantity of fuel to be issued in kind or the commuted amount to be paid for each officer to the owner of the premises. These conditions are commented upon with a view of indicating some of the difficulties which are now encountered under the regulations relative to the issue of fuel in kind to officers or noncommissioned officers when serving other than at a military post and

at a station where no public quarters are available, and to indicate in some measure the impracticability of arriving at an exact amount which will fulfill all conditions accurately.

ACTUAL COST OF HEATING IN APARTMENTS AND CLUBS.

1. With a view to determining definitely the actual amount of fuel necessary to heat a room in an apartment or club, this office, with the consent of the management, has conducted tests and obtained data relative to the heating of the Army and Navy Club and the following apartments in the city of Washington:

The Wyoming.
The Westmoreland.
The Highlands.
The Belmont.

2. When it is stated that the obtaining of this data involves looking into affairs which are considered more or less of a confidential nature by the various managements of the institutions referred to, it will be readily understood that the obtaining of this data has been accompanied by numerous difficulties and delays. The data as presented herein, however, is accurate and can be vouched for in every particular. The tests conducted at the apartments named were made under the personal supervision of a competent engineer of this office, assisted by the engineers on duty at the apartments concerned. The details of conducting the tests are contained in the reports appended hereto. From the data obtained the following results have been computed:

ARMY AND NAVY CLUB.

3. The total heated space in the Army and Navy Club is 960,000 cubic feet.

The heated space included in bedrooms, and in bathrooms, closets, etc., in connection therewith, is 150,000 cubic feet.

Total number of rooms in the club, 69.

The records in the office of the treasurer, Army and Navy Club, show that it cost for heating the club from January 1, 1913, to December 31, 1913, $2,476.62. This is the total cost of fuel for all the steam boilers.

The cost of attendance, including salaries and meals for engineers and firemen was $282.50 per month.

The cost of fuel for the boilers during the summer was $534.80. This amount is necessarily included in the total fuel cost referred to above.

Steam was used for heating from January 1, 1913, to May 15, 1913, and from October 19, 1913, to December 31, 1913, or a period of seven months.

Based on the above data, the following computations have been made, it being assumed that the private heated space in the club is heated 20 hours per day and the public heated space 16 hours out of the 24 on an average.

Total cost of steam for cooking, heating water, etc., for the entire year would be $1,283.52. This amount deducted from the total fuel cost of $2,476.62 would leave $1,193.10 as the cost of fuel for heating only.

The $1,214.50, cost of attendance during the seven heating months, is charged to heating.

Therefore, the total cost of heating for seven months would be the sum of $1,193.10 plus $1,214.50, or $2,407.60. To this amount should properly be added depreciation on the heating system at the usual rate, 3 per cent, which would amount to $552.84.

Cost of repairs during 1913 was $61.

The total cost of the heating system, therefore, for the year 1913 was $3,021.44.

The total number of cubic feet heated for the seven months was 665,000.

Cost, therefore, per cubic foot would be 0.454 cent.

Cost per room per heating season (seven months) would, therefore, be $8.22.

Cost of heating public space is a proportionate charge which should be charged against individual rooms for the season, and amounts to $5.92 per room.

Total cost per room per season (seven months) is, therefore, the sum of $8.22 plus $5.92, or $14.14 per room.

The cost per room per month, therefore, is $2.02.

It will readily be understood that this amount is the heating cost only, to which the actual cost of cooking and heating water should be added in order to give the officer his total allowance as provided at a military post.

THE WYOMING.

1. This apartment is fitted with a gravity return heating system and is heated by return tubular boilers, using bituminous coal, at a cost of $3.80 per ton. Hot water for the building is provided by two separate, internally fired heaters, using same type of coal.

2. From the tabulated results of the test in this apartment it will be noted that the cost of heating a room per season of seven months is $9.61. The total cost per room per heating season and heating water is $10.32. Reducing these values to that of heating a standard room of 3,000 cubic feet, the costs are as follows:

Per heating season, seven months	$7.98
Per room per month	1.14

3. Separate tests were made at different temperatures, and the results show that fuel consumption in a large apartment house such as this is proportionately higher in mild weather than during severe weather. This is readily understood when it is pointed out that the general tendency is to open windows when room temperatures are too high, rather than shut off heat at radiators.

THE HIGHLANDS AND WESTMORELAND.

1. These apartments are equipped with a vacuum heating system and are both heated by exhaust steam from the power plant installed in the Highlands.

2. The conditions existing in these two apartments are such as to reduce the cost of heating to a minimum, in view of the fact that the heat is obtained from a power plant installed for other purposes, and at certain seasons of the year the heating thereof is more or less of a by-product.

3. Referring to the tabulation, it will be noted that the total costs per room for heating only for a heating season of seven months for these two apartments, are as follows:

Highlands	$8.06
Westmoreland	7.87
Total cost per room for heating and heating water:	
Highlands	9.94
Westmoreland	9.30

4. Reducing these values to that of a standard room in order to compare with results obtained at Fort Myer and Washington Barracks the cost is as follows:

Total cost per room per heating season, 7 months:	
Highlands	$9.58
Westmoreland	8.42
Cost per room per month:	
Highlands	1.37
Westmoreland	1.20

THE BELMONT.

1. The Belmont is equipped with a gravity return heating system and heated by a cast-iron, low pressure boiler, using bituminous, run-of-mine coal. Hot water for the building is heated by an internally fired cast-iron heater, using the same fuel.

2. Cost of heating and heating water in this building is exceedingly low, total cost per heating season per room being $9.09.

1. The results obtained in all the apartments above referred to and the Army and Navy Club are tabulated in the table following.

	Name of apartment and how heated.				
	Wyoming, live steam.	Highlands, exhaust steam.	Westmoreland, exhaust steam.	Army and Navy Club, live steam.	Belmont, live steam.
Number of cubic feet of heated space	1,403,968	849,882	650,664	960,000	160,500
Cubic feet of public heated space not chargeable against rooms	None.	84,000	16,522	810,000	None.
Cubic feet of heated space chargeable to rooms	1,403,968	765,882	634,142	150,000	160,500
Number of rooms	388	302	226	69	48
Number of apartments	88	72	54	None.	8
Average size of room, cubic feet	3,618	2,535	2,805	2,175	3,345
Total annual cost of coal for heating and heating hot water	$2,500.00	$2,400.00	$1,515.00	$1,193.00	$261.00
Total annual cost of coal for heating hot water only	276.00	568.00	324.00	(1)	(1)
Annual labor and repair charge for heating and heating hot water	900.00	600.00	400.00	1,275.00	100.00
Approximate cost of heating system	20,000.00	11,000.00	8,000.00	18,428.00	2,500.00
3 per cent depreciation	600.00	330.00	240.00	553.00	75.00
Total cost for heating and heating hot water	4,000.00	3,330.00	2,155.00	(1)	436.00
Total cost for heating and heating hot water chargeable to rooms only	4,000.00	3,000.00	2,100.00	3,021.00	436.00
Total cost per room for heating only	9.61	8.06	7.87	14.14	(1)
Total cost per room for heating and heating hot water	10.32	9.94	9.30	(1)	9.09
Total cost per room for heating hot water only	0.71	1.88	1.43	(1)	(1)
Average ($1.62)	7.98 1.14	9.58 1.37	8.42 1.20	19.50 2.78	.....

[1] Not determined.

2. In connection with the costs of heating a standard room in apartments as compared with a standard room of dwellings it must be borne in mind that the costs will necessarily be materially less in apartments, due to the fact that, with the exception of the outside rooms, all rooms are more or less protected by the other rooms and are not subject to the same exposures as in private dwellings. The costs obtained, therefore, appear reasonable and are what was to be expected as compared with the heating of a separate dwelling or officers' quarters at military posts. The compactness and low cost of fuel and the obtaining of heat as a by-product from central plants must necessarily make the cost in apartments and buildings, such as the Army and Navy Club, materially less.

ZONES OF EQUAL TEMPERATURE AND FUEL ALLOWANCES FOR OFFICERS AND ENLISTED MEN.

1. Based on the foregoing costs of heating in apartments, taken in connection with the cost of heating a standard room, referred to in the report of fuel tests following, allowances for zones of equal temperature have been computed and tabulated in the table herewith.

2. A study of the temperature charts appended hereto indicates that for the United States proper the months are grouped into seasons, as follows:

Seasons.	Months.	Zones of equal temperature.
		° F.
Winter (cold)	December	0–20
	January	20–30
	February	30–40
		40–60
Early spring and late fall (fairly cold)	March	25–35
	November	35–45
		45–65
Spring and fall (warmer)	April	35–40
	May	40–50
	October	50–70
Summer (hot)	June	
	July	45–55
	August	55–75
	September	

3. The zones of equal temperature are numbered from 1 to 13, and, based on the cost of heating above determined, there have been computed the actual costs of heating for the various zones. These allowances are the maximum allowances per room per month for fuel and include the necessary amount of fuel for cooking and heating water as well as heating.

4. Reference to the table showing a comparison of the present allowances with the new allowances established for zones of equal temperature and giving therein the decrease for the coldest and warmest zone as compared with the allowances for the present zones, based on latitude, clearly indicates the value of the new system of allowances and the necessity for basing the same upon the amount of fuel actually necessary in the several zones of equal temperature given.

5. The values given in the table are the maximum allowances per room per month for officers and enlisted men on duty with or without troops and not occupying public quarters at military stations. It is not contemplated that these amounts will be considered as commutation of heat and paid to officers and enlisted men, but that the amounts will fix the maximum allowance to be paid as a reimbursement for the cost of heat for the number of rooms actually occupied within the authorized allowance for the officers or enlisted men concerned, taking into account the locality in which stationed at the time such reimbursement is made.

6. The allowances contained in the table for the several zones of equal temperature are based on coal, at $7 per ton, with a fuel equivalent of 1,700 pounds per cord of standard oak wood. At points other than within the vicinity of the city of Washington the cost of fuel will be different from that of $7 per ton and the equivalent of fuel used will also vary from 1,700 pounds per cord of standard oak wood. It will be necessary, therefore, in certain localities

to apply a correction to the values given in the table. For this purpose the following equation should be used:

$$\text{Cost per room per month} = \frac{\text{Fuel equivalent of coal used}}{1{,}700} \times \frac{\text{Cost per long ton}}{\$7} \times \text{Table value for month in question.}$$

For example: At Salt Lake City, Utah, coal costs $5.26 per ton. The equivalent for Pleasant Valley bituminous is 2,822 pounds. The cost per room per month for a major on detached service in Salt Lake City during the period December, January, and February would then be:

$$\text{Cost per room per month} = \frac{2{,}822}{1{,}700} \times \frac{\$5.26}{\$7} \times \$3.10 = \$3.86.$$

7. Considering the mean minimum temperatures for the Canal Zone, Porto Rico, Hawaiian Islands, Philippine Islands, and Alaska, the allowances for posts in those localities should be fixed as follows:

For the Hawaiian Islands, Canal Zone, and Porto Rico the allowances given in zone No. 13, the year round.

Philippine Islands: The allowances given in zone No. 13, except at Camp John Hay and Camp Keithley, for which posts the allowances given in zone No. 12 should apply.

Alaska: For the months of January, February, March, April, October, November, and December, the allowances given in zone No. 1; for the months of May, June, July, August, and September, the allowances given in zone No. 2.

8. With a view to establishing the allowances for officers on detached service in foreign cities, the cost and kind of fuel used in the several cities has been determined and is appended hereto. There have been obtained from the Weather Bureau the mean minimum temperatures for the cities concerned, and it is believed that the allowances should be as follows:

	Zone No.
Mexico City, Mexico:	
December, January, February	3
March, November	7
April, May, October	10
June, July, August, September	13
Berne, Switzerland:	
December, January, February	1
March, November	5
April, May, October	10
June, July, August, September	12
Stockholm, Sweden:	
December, January, February	1
March, November	5
April, May, October	9
June, July, August, September	12

	Zone No.
Berlin, Germany:	
December, January, February	1
March, November	5
April, May, October	10
June, July, August, September	12
Constantinople, Turkey:	
December, January, February	2
March, November	6
April, May, October	10
June, July, August, September	13
Vienna, Austria:	
December, January, February	1
March, November	5
April, May, October	10
June, July, August, September	12
Peking, China:	
December, January, February	1
March, November	5
April, May, October	10
June, July, August, September	12
Brussels, Belgium:	
December, January, February	1
March, November	6
April, May, October	10
June, July, August, September	12
London, England:	
December, January, February	1
March, November	6
April, May, October	10
June, July, August, September	12
St. Petersburg, Russia:	
December, January, February	1
March, November	5
April, May, October	9
June, July, August, September	12
Santiago de Cuba: For the year round	13
Tokyo, Japan:	
December, January, February	2
March, November	7
April, May, October	10
June, July, August, September	12
Paris, France:	
December, January, February	2
March, November	7
April, May, October	10
June, July, August, September	12
Quito, Ecuador:	
December, January, February	3
March, November	8
April, May, October	11
June, July, August, September	13

	Zone No.
Madrid, Spain:	
December, January, February	2
March, November	7
April, May, October	10
June, July, August, September	12
Rome, Italy:	
December, January, February	2
March, November	6
April, May, October	11
June, July, August, September	13
Monrovia, Liberia: For the year round	13
Rio de Janeiro, Brazil: For the year round	13
Lima, Peru: For the year round	13

SUMMARY AND CONCLUSIONS.

Based on what has preceded, the following conclusions are reached and recommendations made:

First. That fuel in kind be issued to officers and enlisted men entitled to and occupying public quarters at military posts, based on the building, the apparatus installed in such building and the mean outside temperature.

In connection with the advisability of promulgating regulations to carry into effect the above method the following question was submitted to the Judge Advocate General of the Army for his opinion:

(*a*) Under the act of Congress above referred to can the Secretary of War authorize the furnishing of the necessary fuel for heating quarters actually occupied by officers at military posts, based on the building, the apparatus installed in such building, and the outside temperature, instead of fixing the allowance for the grade of the officer occupying such building?

To which question the Judge Advocate General of the Army replied:

It will be observed that the act limits the amount of the heat and light authorized to be furnished to that which is "actually necessary for the *authorized allowance of quarters*," and while the act provides that the same shall be furnished "under such regulations as the Secretary of War may prescribe," it is clear that the authority to issue regulations is to be exercised within the limits conferred by the act authorizing their issue. Any regulation which would authorize the heating of an eight-room building for occupancy by an officer whose allowance is four rooms only would not be within the limits of the authority conferred, which is to furnish heat for the *authorized allowance of quarters*. The question at to what is the authorized allowance for officers occupying *public quarters* has not received full consideration. * * * Heretofore, it has been assumed, but without thorough consideration, that the authorized allowance is that prescribed in the act of June 17, 1878 (20 Stat., 151), as amended by the act of March 2, 1907 (34 Stat., 1168), which prescribes the allowance of two rooms for a second lieutenant, three for a first lieutenant, four for a captain, etc. While this statute is so worded as to call for the assignment of the number of rooms specified therein to officers of the respective grades, its primary purpose was to fix the allowance of quarters with reference to the amount which should be allowed to officers of the respective grades on a commutation status. Congress has authorized, by appropriations on estimates regularly submitted, the construction of buildings at the several military posts on plans adapted for occupancy of a single officer only, in

which the number of rooms exceeds that prescribed by this statute. In the sundry civil act of June 25, 1910 (36 Stat., 721), it is provided:

"That hereafter no money appropriated for military posts shall be expended for the construction of quarters for officers of the Army, or for barracks and quarters for the artillery, the total cost of which, including the heating and plumbing apparatus, wiring and fixtures, shall exceed, in the case of quarters of a general officer, the sum of fifteen thousand dollars, of a colonel or an officer above the rank of captain, twelve thousand dollars, and of an officer of and below the rank of captain, nine thousand dollars."

The limits of cost here fixed clearly cover the construction of buildings for officers of the respective grades in which the number of rooms would be more than the number fixed as the allowance of the respective officers by the statute hereinbefore referred to. The quarters are designated as "lieutenants' quarters," "captains' quarters," "field officers' quarters," etc.; and officers of the respective grades are assigned to the same and are required to occupy them. It is clearly the intent of the act of March 2, 1907, supra, that the quarters assigned to an officer should be heated and lighted at the expense of the United States, and if the heat and light furnished is limited strictly to the number of rooms fixed by the statute above cited as the authorized allowance for officers of the respective grades, the intent of the statute that the quarters should be heated and lighted at the expense of the United States would not be complied with. Here arises a situation which is so obviously unjust to the officer that it is believed that some way should be found of avoiding the injustice. The reasonable way to do this would be to regard the building of quarters by the Government in excess of the officer's allowance, and the assignment of them to the officer, who has no option in respect of occupying them, as authorizing the use of a larger number of rooms in public quarters than those specified in said acts. I am therefore of opinion that the term "authorized allowance" as used in the heat and light statute, *when applied to public quarters at military posts*, should be construed as having reference to the quarters actually constructed by the United States for officers of the respective grades, and that the regulations prescribing the amount of fuel which may be issued may be properly based on the building, the apparatus installed therein, and the outside temperature, instead of fixing the allowance for the grade of the officers occupying such building.

(*a*) It is therefore recommended that the issue of fuel in kind to officers and enlisted men on duty at military posts, entitled to and occupying public quarters, be based on the building, the apparatus installed in such building, and the outside temperature.

Second. That the fuel allowances for officers and enlisted men, on duty with or without troops, and occupying quarters other than public, be based upon the actual quantities of fuel necessary, the said officers and enlisted men to be reimbursed for the value of the fuel allowance for the number of rooms actually occupied, but not exceeding the number to which the rank of the officer or enlisted man entitles him, as set forth in Army Regulations, 1044, and not exceeding the maximum allowances given in the table for the zone of equal temperature in which serving.

Relative to the legality of establishing allowances in this manner, the Judge Advocate General of the Army states:

The comptroller, however, has held (19 Comp. Dec., 675), that the effect of the several regulations of the War Department on the subject referred to in his decision amounted to a practical commutation to officers of the maximum amounts of their

heat and light allowances in cases where quarters other than public are occupied, and neither the heat nor light allowance therefor is separately measured; and that there was no objection to making the payment of the commuted value of these allowances directly to the officer—such payment, however, to be limited to the maximum allowance for heat and light for the rooms *actually occupied* by him for the period stated.

I am therefore of opinion that while the statute provided for an allowance in kind so that a flat rate can not be authorized by regulations by way of commutation of the heat and light allowance, independent of the amount expended by the officer for the purpose, it would be competent to provide by regulation that an officer occupying quarters other than public, where the heat and light are not separately measured, will be reimbursed in the amount fixed by the regulation as the amount of heat and light actually necessary for heating and lighting the number of rooms actually occupied by him in the locality where situated; and that where the heat and light are separately measured, and are not furnished in kind by the Government, he will be reimbursed for the actual cost of the same, within the maximum allowance authorized for the number of rooms occupied by him.

(*b*) It is therefore recommended that officers and enlisted men, on duty with or without troops, entitled to and occupying quarters other than public, will be reimbursed for the number of rooms actually occupied at the rates prescribed in the table herein for the zones of equal temperature in which such officers or enlisted men might be serving.

Third. That where an officer or enlisted man is on detached service in a foreign country and occupying quarters other than public such officer or enlisted man be reimbursed for the actual number of rooms occupied, but not exceeding the number to which the rank of the officer or enlisted man entitles him as set forth in Army Regulations, 1044, at the rate fixed for foreign cities hereinbefore referred to.

There is submitted, appended hereto, suggested amendments to Army Regulations necessary to carry into effect the recommendations above made.

FRANK T. HINES,
Captain, Quartermaster Corps.

FUEL TESTS.

1. In accordance with the verbal instructions of the Secretary of War of February 7, 1914, this office commenced fuel tests at Fort Myer, Va., Washington Barracks, D. C., and Fort Sheridan, Ill., with a view to definitely determining the actual amount of fuel necessary to heat barracks and quarters occupied by officers and enlisted men at the stations named. Also the quantities actually necessary for cooking and heating water.

2. With a view of determining, if possible, zones of equal temperature, this office conferred with the Weather Bureau and succeeded in obtaining data on which to base the temperature charts submitted as part of this report.

3. Also with a view of having the data determined by the fuel tests in question in such form that it could not be questioned, as well as obtaining a disinterested and impartial recommendation in connection therewith, this office addressed letters under date of February 7, 1914, to the Bureau of Mines and the Bureau of Standards, informing those bureaus that this office was about to commence fuel tests at the posts named and requested cooperation, if practicable, of the bureaus in question, in connection with these tests.

4. The greatest assistance and cooperation has been given by the Weather Bureau, and especially by the chief of that bureau, Prof. C. F. Marvin, in furnishing this office with data on which the temperature charts referred to heretofore have been established.

5. The Assistant Secretary, Department of the Interior, in letter dated February 13, 1914, acknowledged receipt of letter from the Secretary of War, asking cooperation of the Bureau of Mines in the tests referred to, and stated that a representative of the Bureau of Mines would be directed to confer with this office relative to the fuel tests in question. On February 12, 1914, Mr. George S. Pope, of the Bureau of Mines, called at this office and consulted with a representative of this office relative to the fuel tests being conducted at Fort Myer, Va., and Washington Barracks, D. C. The fuel situation was discussed in detail with Mr. Pope by Capt. Frank T. Hines, Quartermaster Corps, of this office, and the object of the tests above referred to fully explained. A copy of the memorandum and a complete set of forms used in connection with the tests and instructions relative to the same were turned over to Mr. Pope, at his request, in order that he might have an opportunity to study the scheme outlined more thoroughly.

6. Mr. Pope agreed with Capt. Hines that the scheme as outlined would undoubtedly result in obtaining valuable data and greatly improving existing conditions. He further stated that he felt that the conducting of the tests in question would not only afford valuable information to this corps, but would probably be of great value to other departments and to the public generally. He assured this office that the Bureau of Mines would cooperate in every way practicable and assist as much as possible in conducting the tests. He further stated that a representative of the bureau at Pittsburgh would be ordered to Washington for that purpose, the representative referred to being one who had had considerable experience in the question of heating apparatus and in the theoretical side of heating, radiation, etc.

7. In letter of February 17, 1914, the Secretary, Department of Commerce, informed the Secretary of War that the Bureau of Standards had no information that was immediately available on the subject of fuel tests. It was promised, however, that that bureau would make an investigation in order to determine if the information existed elsewhere and render whatever assistance it might in connection with the matter. No representative of that bureau appeared during the time the tests referred to were conducted.

8. Mr. S. B. Flagg, representing the Bureau of Mines, called at this office on March 13, 1914, and took up in detail with Capt. Hines the subject of the fuel tests being conducted by this office. Mr. Flagg also visited Washington Barracks, D. C., and investigated the methods of conducting the fuel tests referred to. He stated that he fully agreed with the conditions under which the tests were being conducted and felt perfectly sure that very valuable data would be collected. From information obtained from Mr. Flagg it was learned that the present fuel equivalents established by the Bureau of Mines are not thoroughly reliable. In view of the conditions under which fuel is used at military posts, Mr. Flagg stated that it would appear advisable for the Bureau of Mines to again determine the fuel equivalents. This office thoroughly agrees with this opinion and has for some time felt that more accurate data relative to these equivalents should be established.

9. Preliminary to the commencement of the tests at the posts named, the heating apparatus in all buildings was carefully inspected by engineers of this office. The methods of firing and keeping of the apparatus in proper repair were also noted.

10. It was noted that in practically every case a large accumulation of soot and dust was found on the baffles or on the flues in the furnaces at the posts referred to. In several instances the condition of the furnaces would seem to indicate that they had not been cleaned since

their original installation. The condition of the doors and methods of firing were such as to clearly indicate that those in charge were not familiar with the proper manner of firing heating boilers, and in no instance was the apparatus found to be in proper order. Temperature regulators, draft doors, etc., were not in working condition and not properly set.

11. In order that the data in connection with the tests might be accurately and reliably kept, three sergeants, Quartermaster Corps, were assigned to each of the posts—Fort Myer, Va., and Washington Barracks, D. C.—and, preliminary to the tests, were carefully instructed relative to the object of the tests and the results it was hoped to obtain. Detailed instructions, copies of which are hereto appended, were furnished the post authorities and also the enlisted men placed in charge of the tests.

12. All heating apparatus was thoroughly and carefully cleaned and placed in working order before the tests commenced.

13. There was assigned at each post an officer directly in charge of the tests, under the post quartermaster. Two engineers were also assigned in connection with this work, one to Fort Myer, Va., and one to Washington Barracks, D. C. Frequent visits, practically daily visits, were made to the posts named by the engineers in question and the tests and keeping of the data were carefully watched. An officer of this office also made frequent visits to the posts named, with a view to keeping in touch with the progress of the tests.

14. It can be safely stated that the data obtained at these tests, which is tabulated and attached hereto, is accurate and definite, and it is believed from the results and conclusions drawn in connection therewith, that the same may be relied upon to give satisfactory results in connection with the rules relative to the issue of fuel recommended in this report.

15. The details and manner of conducting the tests at each post will be found in the reports of the post authorities and those of the engineers on duty in connections with the tests, appended hereto.

WASHINGTON BARRACKS, D. C.

1. The objects of the fuel tests conducted at this post were:

First. To test the reliability of fuel allowance charts;

Second. To determine the actual cost of heating buildings and the cost of fuel necessary for cooking and heating water in officers' and noncommissioned officers' quarters.

2. Appended hereto will be found daily records of temperatures and coal consumption of the several buildings at this post, as well as the tabulation giving a summary of the results obtained during the tests at this post.

3. Each daily record chart for the several officers' quarters and barracks has been plotted and the curves determined, with a view of affording a satisfactory way of studying the results and drawing conclusions therefrom. Each chart shows by the curves indicated thereon the average daily inside temperatures, the average daily outside temperatures, the wind movement and direction, the average daily coal consumption with coal allowance calculated from charts previously prepared in this office and contemplated to be used in connection with fuel issues at military posts.

4. Following the daily record charts for each building, there is given a chart showing the averages for the 11 officers' quarters for which individual charts were prepared.

5. The conditions, so far as heating apparatus is concerned, at Washington Barracks were ideal, as the type of heating apparatus in each set of quarters was the same, the only variation being in the size of such apparatus.

6. A study of the daily record charts of the buildings in question leads to the following conclusions:

(*a*) The outside temperature varied, in so far as data plotted on the chart is concerned, from 12° to 62° F. The weather conditions during the tests were quite varied, ranging from a warm day, when the temperature was 50° at 8 a. m., to a temperature, for a short period, of 3° at 8 a. m. on another day. There were several storms during the period, one a blizzard, on March 1–2, with a wind sufficiently high to break many windows and result in freezing some exposed pipes.

(*b*) The inside temperatures were fairly constant, the greatest variation being 8°, and this only on one occasion, the inside temperature being maintained at practically 70°.

(*c*) The fuel allowances as determined from the fuel charts previously prepared in this office were sufficient on all occasions, except in cases of a sudden rise in temperature or where a combination of low temperature and high wind occurred, in which cases the fuel consumption slightly exceeded the allowances as given by the chart.

(*d*) That the allowances as given on the fuel charts on the average are slightly too great at low temperatures and insufficient at high temperatures for the apparatus installed at this post. This will readily be seen by an inspection of the chart showing a "Comparison of chart allowance curve and actual consumption curve," accompanying, where the actual results of the tests have been plotted and a new curve established. It will be seen that the slant of the original curve on the charts prepared by this office was too great, making the allowances too large at low temperatures and too small at higher temperatures. When it is considered that the greatest waste of fuel takes place at high temperatures, it is believed advisable to have this condition exist, provided no undue hardship will result.

(*e*) The wind velocity has a decided effect on the coal consumption, as will be noted, particularly on the charts for the period March 1–3, where the high wind materially increased the coal consumption.

COST OF HEATING OFFICERS' QUARTERS.

1. Referring to the tabulation of results obtained at Washington Barracks, it will be noted that the officers' quarters at this post are of two classes—those for field officers, consisting of 12 rooms, and those for line officers, consisting of 10 rooms.

Considering the results obtained at Washington Barracks and Fort Sheridan, it will be seen that the allowances as fixed by the fuel charts are practically correct and it would be inadvisable to make any change in the charts at this time.

2. It will be noted from the tabulation that the average quantities of coal used per day for heating, as well as for cooking and heating water, are given. The only satisfactory manner of comparing the cost of heating is to reduce that cost to the cost per cubic foot, and with this in view, the number of pounds of coal per cubic foot of heated space, as well as the total average coal used per day for heating, is given in the tabulation. It will be noted that the amount of coal necessary for heating houses of different sizes is not in direct proportion to the number of rooms. However, it will be seen that the cost of heating per cubic foot is in proportion to the size of building, and the results obtained in the tests at this post give regular and consistent data in that regard.

3. A study of the results obtained indicated that there is no one rate per room that would be fair, due to the fact that a larger proportion of fuel per room is required for a small house as compared with a larger one. The larger houses have, as a rule, a greater number of bedrooms, which have a material effect upon the amount of fuel required.

4. In determining, therefore, the cost of heating per room, it is necessary to arrive at some standard basis for size of room, in order that the cost of heating per cubic foot may be applied thereto.

5. So far as can be determined, this question has not been definitely settled heretofore, and the only reference thereto in regulations or acts of Congress this office has been able to find is contained in the Regulations of the Army, 1834, where, on page 138, paragraph 41, the following is stated:

> 41. Rooms for officers shall be as established at 225 square feet.

The regulations from which the above is quoted are based upon the acts of Congress of 1821, as contained in volume 2, Document 199, of State Papers.

6. Authorities seem to differ greatly on the amount of air required per person per hour, and as this requirement necessarily determines

the size of the ordinary room, authentic data on this point was looked for.

It is believed that the most reliable data on the subject is given in the publication, Preventative Medicine and Hygiene, by Milton J. Rosenau, one of the highest authorities on hygiene in this country. In reference to this subject Dr. Rosenau states:

> That the accepted amount of pure air required per person per hour is from 2,000 to 3,000 cubic feet. This does not mean that there should be 3,000 cubic feet for each person in an inhabited room, for it is sufficient if the air space is 1,000 cubic feet, provided, of course, the air is changed three times an hour.

This same authority further states:

> The size of rooms for dwellings and workshops is somewhat of an economic question, but they should be large enough to allow the air to be replaced two or three times an hour without causing perceptible drafts. The minimum space, in accordance with this standard, is about one-third the quantity of air per hour—i. e., from 700 to 1,000 cubic feet per person. * * * Soldiers in barracks are allowed 600 cubic feet per head, and the limit for lodging houses is usually fixed from 300 to 500 cubic feet.

7. Based on the above, it may, therefore, be assumed that as the standard family is taken at five persons, the size of a standard room in cubic feet can reasonably be taken at five times the quantities fixed by the authority above quoted, i. e., at 2,500 cubic feet. In addition to the actual space contained in the room itself, there is a certain amount of additional space contiguous thereto in a building which is heated along with the several rooms and is necessarily chargeable thereto.

Reference to the tabulated reports of tests and the data given on heating apartments, it will be seen that the average number of cubic feet of heated space chargeable to each room is approximately 3,000. The standard room, therefore, used as a basis of comparison in this report is taken as 3,000 cubic feet.

8. In considering this question it must be borne in mind that the space occupied by furniture and fixtures should be allowed for, and when it is considered that the ordinary height of ceilings in dwellings is from 9 to 10 feet, it will be found that, applying this height to the standard room referred to in the regulations of 1834, a room 15 by 15 by 10 feet would equal 2,250 cubic feet. Allowing 250 cubic feet for furniture and fixtures and adding thereto the additional space chargeable to each room, 3,000 cubic feet as a standard room will be very close to the average and fulfill the necessary hygiene conditions. This opinion is also concurred in by the Office of the Surgeon General of the Army, and a reference to the tabulation of sizes of rooms in officers' quarters, taken from the plans on file in this office, would seem to further indicate that a room of this size comes nearest to the average

9. Referring to the tabulation of results obtained at Washington Barracks, the following data relative to the cost of heating a standard room per month is obtained, each type of house being considered separately:

FIELD OFFICERS' QUARTERS.

[Twelve-room houses.]

1. For a mean outside temperature of 24.17°, it was found that the average pounds of coal per cubic foot of heating space are 0.0084, and the cost of coal for heating at this post is $7 per long ton (2,240 pounds). The cost of heating a standard room per month would, therefore, be:

$\frac{0.00843 \times 3{,}000 \times 30 \times 7}{2{,}240} = \$2.38$, equals the average cost of heating 1 standard room per month (in 12-room house).

2. In a similar manner for the several mean outside temperatures given, the results have been calculated and are as follows:

Cost of heating a standard room of 3,000 cubic feet with coal at $7 per ton (2,240 pounds).

For a mean outside temperature of—	Difference in mean temperatures.	Average pounds of coal used per cubic foot per day.		Cost per room per month.		Average (mean).
		In 12-room houses.	In 10-room houses.	In 12-room houses.	In 10-room houses.	
°F.	°F.					
24.17		0.0084	0.0106	$2.38	$2.98	$2.68
29.90	5.73	.0083	.0104	2.34	2.93	2.64
34.00	4.10	.0058	.0083	1.63	2.34	1.99
41.91	7.91	.0057	.0071	1.61	1.99	1.80
Means	17.74	.00705	.0091	1.99	2.56	2.28

3. Referring to the results tabulated, it will be noted that the differences in cost generally increase in regular increments with the temperature; for instance, the increase in cost for a change of temperature from 24.17° to 29.90°, or a difference of 5.73°, is only 4 cents. From 29.90° to 34°, or a difference of 4.1°, an increase in cost of 65 cents per standard room is obtained. From 34° to 41.91°, or a difference of 7.91°, a difference in cost of only 19 cents is obtained.

4. These facts would seem to indicate, as was to be expected, that in passing from a temperature just above freezing to one below freezing necessarily causes the greatest increase in the amount of coal needed; likewise, that the amount of fuel necessary for a decrease of temperature from a temperature below freezing to a lower temperature below freezing is not in direct proportion and is relatively small; that the decrease in the amount of fuel necessary for a tem-

perature above freezing to a higher temperature above freezing is not in direct proportion to the increase of temperature, and is likewise relatively small.

FORT MYER, VA.

1. The fuel tests at this post were conducted along similar lines to those outlined preceding for Washington Barracks. The details of the test are contained in the report of the engineer directly in charge of the tests at this post, attached hereto.

2. In reviewing the results of the tests conducted at this post attention is invited to the fact that the weather conditions were exceedingly favorable for obtaining conclusive data upon which to base definite recommendations. The range of daily mean outside temperatures were from plus 11.9° F. on February 24 to 62° F. on March 25. It was also possible to divide the tests into four distinct periods, during which there was considerable variation in the outside temperature. In addition to the varied temperature conditions there was one period of excessively high wind—that of March 2, which showed a total wind movement of over 900 miles and a maximum wind velocity during this period of about 65 miles per hour.

3. On the tabulation and charts herewith are shown the condensed records for the various buildings of the post. The data, with very few minor exceptions, is exceedingly consistent, and the results, even when reduced to the cost per cubic foot, lead to definite conclusions relative to the amount of fuel used for various purposes. During the tests at this post, as well as at Washington Barracks, no special attempt was made to economize or obtain test conditions, but actual conditions relative to coal consumption, bearing in mind the comfort of those involved, were considered.

4. In the table following will be found the cost of heating a standard room of 3,000 cubic feet with coal at $7 per ton, as determined from the actual tests at this post. The table gives in detail for the several outside temperatures the average pounds of coal used per cubic foot of heated space, the cost per room per month in houses varying from 4 to 11 rooms, and the mean average cost per room per month.

5. This tabulation leads to the following conclusions:

(*a*) That the cost of heating a standard room per month varies in accordance with the number of rooms contained in the building and the mean outside temperature, the heating apparatus in such building being constant.

(*b*) That it costs more to heat a standard room in a small house of 4 or 5 rooms than it does to heat the same room in a larger house of 10 or 11 rooms.

(*c*) That a drop of temperature from a temperature just above freezing to a temperature just below freezing gives the greatest variation in coal consumption.

(*d*) That the increase in cost of heating a standard room for a drop of temperature from some fixed temperature just below freezing to a still lower temperature below freezing, is relatively small within the temperature limits found at the time of the test.

(*e*) That the change in cost of heating a standard room due to a change in temperature from some fixed temperature above freezing to a higher temperature above freezing, is also relatively small.

6. In the table referred to, attention is invited to the fact that the six-room and four-room houses are noncommissioned officers' quarters, heated by stoves, and therefore can not be readily compared with the other sizes of houses given. These quarters are heated partly by the kitchen range and partly by separate stove installed in one of the lower rooms, no heating apparatus being used in the upstairs rooms. In these buildings, it will be noted, the cost per standard room is relatively low and is due undoubtedly to the fact that a large part of the heating of the lower floor is taken care of by the kitchen range.

COST OF COOKING.

1. The cost of cooking and heating water in officers' and noncommissioned officers' quarters has been tabulated and the results are given in the table herewith. Referring to that table, it will be noted that the cost of cooking and heating water is not in direct proportion to the number of rooms in the house, except in so far as the size of the house has a bearing on the number of people living therein. The cost per room per month, however, has been calculated.

2. In view of the fact that part of the fuel used in the kitchen range is also used for heating the kitchen, it is found that the cost of heating varies with the outside temperature. The tabulation of the total amounts used for the two months, February and March, for which months a difference in mean outside temperature of 10.81° obtained, shows that the following percentage of increase in the amount of fuel used for a change of temperature of 10.81° would obtain:

Fort Myer, Va.

	Per cent.
Officers' quarters	33
Noncommissioned officers' quarters	29
Barracks and other buildings	21

Washington Barracks, D. C.

	Per cent.
Officers' quarters	2
Noncommissioned officers' quarters	26
Barracks and other buildings	18

FORT SHERIDAN, ILL.

1. The results obtained at Fort Sheridan, Ill., are shown in the tabulation hereto appended. From the data submitted from this post it will be seen that the conclusions reached from the results obtained at Fort Myer and Washington Barracks apply equally to the results as shown from the data submitted from Fort Sheridan, and the quantities of fuel used, under like conditions, are practically the same.

2. The observations made on this test have been tabulated as far as practicable and are similar to the tabulations adopted for recording tests at Fort Myer and Washington Barracks. A blueprint copy of such tabulation is attached hereto.

3. Two additional graphic charts have been completed, which are hereto appended, showing a comparison of the proposed fuel allowances, based on charts and the actual fuel consumption during the test. It will be noted from these charts that the fuel consumption at Fort Sheridan was somewhat above the proposed allowances. It will also be noted that the actual consumption exceeds the allowances by the greatest amount during the mildest weather. This condition is also noted at the tests at Fort Myer and Washington Barracks. As it is desired to restrict the use of fuel during the mildest weather to a minimum, it is thought that the allowances, under these conditions, should not be increased.

4. It is believed that a greater amount of coal was used at the test at Fort Sheridan than was actually necessary. Had the same supervision been given to the test at this post as was given to the tests at the two posts in the vicinity of Washington, it is thought that the fuel consumption would have been materially less, as, in all probability, the care and cleaning of boilers and adjusting boiler regulators at Fort Sheridan were not given the same consideration as at Fort Myer and Washington Barracks.

Table showing average size of rooms in officers' quarters.

No.	Quarters for—	Story height.		Parlor.	Library.	Dining room.	Kitchen.	Bedroom.	Bedroom.	Bedroom.	Bedroom.	Average.
		First.	Second.									
		Ft.in.	*Ft.in.*	*Ft.in.* *Ft.in.*	*Ft.in.* *Ft.in.*	*Ft.in.* *Ft.in.*	*Ft.in.* *Ft.in.*	*Ft.in.* *Ft.in.*	*Ft.in.* *Ft.in.*	*Ft.in.* *Ft.in.*	*Ft.in.* *Ft.in.*	*Ft.in.* *Ft.in.*
95C	Commanding officer	10 0	9 6	16 2×20 0	15 10×16 0	16 0×21 2	14 6×15 10	16 6×16 10	16 0×21 2	15 10×16 0	12 0×15 10	15 6×17 11
145D	Field officer	10 0	9 6	14 9×17 0	13 3×14 3	14 9×17 0	14 0×16 0	14 9×16 0	12 3×18 6	13 3×14 3	10 3×14 0	13 5×15 11
145F	do	9 6	9 0	14 10×17 2	13 3×14 3	14 10×18 5	14 0×16 0	14 10×16 0	12 0×18 6	13 3×14 3	10 3×14 0	13 5×16 1
142B	2 captains	10 0	9 6	13 9×16 0	11 0×13 9	13 9×18 10	12 10×14 10	14 0×14 10	12 10×13 9	13 9×18 10	12 10×14 10	13 1×15 9
142D	do	9 6	9 0	14 0×15 2	10 6×14 0	14 0×19 0	12 6×15 0	14 0×14 0	12 0×14 0	14 0×19 0	12 6×14 6	12 11×15 7
120F	2 lieutenants	10 0	9 6	11 0×17 0	.....	13 10×16 6	11 10×13 10	14 6×17 0	13 10×16 0	11 10×13 10	.....	13 4×15 8
1201I	do	9 6	9 0	13 2×16 2	.....	15 0×16 8	12 0×16 0	13 8×16 2	15 0×16 8	12 0×14 0	.....	13 6×15 11
235A	Field officer	9 6	9 0	15 0×15 9	15 0×17 0	15 0×16 9	14 0×14 2	14 0×17 0	10 9×14 0	14 0×16 0	14 0×14 0	14 0×15 7
236	Company officer	9 6	9 0	14 2×15 8	.....	14 6×17 0	12 6×12 6	14 6×16 0	14 6×19 0	12 6×12 6	.....	13 9×15 5
256	2 company officers	9 0	9 0	14 4×15 10	.....	14 10×15 6	12 4×12 10	13 10×14 10	14 10×21 0	12 4×12 10	.....	13 7×15 5
260	do	9 0	8 6	13 0×13 3	.....	11 3×16 0	11 2×12 2	10 8×13 10	11 3×13 0	9 6×11 2	.....	11 2×13 3

Average of first group, 13 feet 7 inches by 16 feet 1 inch.
Average of second group, 13 feet 2 inches by 14 feet 11 inches.

Cost of heating a standard room of 3,000 cubic feet, with coal at $7 per ton (2,240 pounds), as determined from actual test at Fort Myer, Va.

For a mean outside temperature.	Difference in mean temperature.	Average pounds of coal used per cubic foot of heating space per day.								Cost per room per month.								Average cost per room per month.	
		11-room house.	10-room house.	9-room house.	8-room house.	7-room house.	6-room house.	5-room house.	4-room house.	11-room house.	10-room house.	9-room house.	8-room house.	7-room house.	6-room house.	5-room house.	4-room house.		
°F.	°F.																		
24.71.....	.....	0.0083	0.0100	0.0095	0.0107	*a* 0.0113 *b* .0104	[1] 0.0064	0.0138	[1] 0.0057	$2.34	$2.81	$2.66	$3.00	*a* $3.18 *b* 2.93	[1] $1.75	$3.88	[1] $1.55	$2.97	[1] $1.65
25.87 [1].....																			
29.91.....	5.20	.0067	.0110	.0081	.0094	*a* .0115 *b* .0101	.....	.0124	.....	1.88	3.09	2.28	2.64	*a* 3.23 *b* 2.81	.....	3.49	.....	2.78	.....
34.00.....	4.09	.0054	.0090	.0078	.0085	*a* .0098 *b* .0087	.....	.0106	.....	1.52	2.52	2.19	2.39	*a* 2.76 *b* 2.45	.....	2.98	.....	2.40	.....
41.91.....	7.91	.0049	.0083	.0072	.0084	*a*. 0087 *b* .0080	[1] .0067	.0102	[1] .0050	1.38	2.33	2.03	2.38	*a* 2.45 *b* 2.25	[1] 1.83	2.87	[1] 1.37	2.24	1.60
36.68 [1].....																			
Means.....	.....	.0063	.0096	.0082	.0093	*a* .0103 *b* .0093	.0066	.0118	.0054	1.78	2.69	2.29	2.60	*a* 2.91 *b* 2.62	1.79	3.31	1.41	2.55	.....

[1] These are noncommissioned officers' quarters heated by stoves. The kitchen and part of lower room is heated by the cooking range; the rest of the house is heated by one stove on first floor.

NOTES.

Type *a* 7-room house has 26,354 cubic feet of heated space, or an average of 3,765 cubic feet of heated space chargeable to each room. These buildings are larger by 2,755 cubic feet than the 8-room quarters referred to in the table.

Type *b* 7-room house has 23,386 cubic feet of heated space, or an average of 3,341 cubic feet of heated space chargeable to each room. These quarters are practically the same size as the 8-room quarters referred to herein.

Cost of heating a standard room of 3,000 cubic feet, as compared with heating rooms of actual size in officers' and noncommissioned officers' quarters at Fort Myer, Va., and Washington Barracks, D. C.

Mean outside temperature.	Difference.	Cost per room per month.																						Average cost per month.	
		12-room house, Washington Barracks, D. C.		11-room house, Fort Myer, Va.		10-room house, Washington Barracks, D. C.		10-room house, Fort Myer, Va.		9-room house, Fort Myer, Va.		8-room house, Fort Myer, Va.		7-room house, Fort Myer, Va. (type A).		7-room house, Fort Myer, Va. (type B).		6-room house, Fort Myer, Va.		5-room house, Fort Myer, Va.		5-room house, Washington Barracks, D. C. (noncommissioned officers' quarters).		4-room house, Fort Myer, Va. (noncommissioned officers' quarters).			
		Actual room.	Standard room.	Actual room.	Standard room.	Actual room.	Standard room.	Actual room.	Standard room.	Actual room.	Standard room.	Actual room.	Standard room.	Actual room.	Standard room.	Actual room.	Standard room.	Actual room.	Standard room.	Actual room.	Standard room.	Actual room.	Standard room.	Actual room.	Standard room.	Actual room.	Standard room.
°F.	°F.																										
24.71	.....	$2.68	$2.38	$2.80	$2.34	$3.05	$2.98	$3.19	$2.81	$2.91	$2.66	$2.95	$3.00	$3.99	$3.18	$3.26	$2.93	.....	.....	$4.24	$3.88	$1.24	$1.80	.....	.....	$3.03	$2.79
[1] 25.87	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	[1] $1.39	[1] $1.75	.....	.....	.....	.....	[1] $0.77	[1] $1.55	[1] 1.08	[1] 1.65
29.91	5.20	2.64	2.34	2.26	1.88	3.00	2.93	3.51	3.09	2.50	2.28	2.59	2.64	4.06	3.23	3.16	2.84	.....	.....	3.81	3.49	1.04	1.50	.....	.....	2.86	2.62
34.00	4.09	1.84	1.63	1.82	1.52	2.40	2.34	2.87	2.52	2.40	2.19	2.35	2.39	3.46	2.76	2.72	2.45	.....	.....	3.25	2.98	.92	1.34	.....	.....	2.40	2.21
[1] 36.68	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	[1] .84	[1] 1.83	.....	.....	.....	.....	[1] 1.68	[1] 1.37	[1] 1.76	[1] 1.60
41.91	7.91	1.82	1.61	1.65	1.38	2.04	1.99	2.65	2.33	2.22	2.03	2.34	2.38	3.07	2.45	2.51	2.25	.....	.....	3.11	2.87	.75	1.09	.....	.....	2.22	2.04

[1] These are noncommissioned officers' quarters heated by stoves. The kitchen and part of lower room is heated by the cooking range; the rest of the house is heated by one stove on first floor.

NOTES.

Type A, 7-room house, has 26,354 cubic feet of heated space, or an average of 3,765 cubic feet of heated space chargeable to each room. These buildings are larger by 2,755 cubic feet than the 8-room quarters referred to in the table.

Type B, 7-room house, has 23,386 cubic feet of heated space, or an average of 3,341 cubic feet of heated space chargeable to each room. These quarters are practically the same size as the 8-room quarters referred to herein.

Summary of cost of cooking and heating water in officers' and noncommissioned officers' quarters.

[Coal cost, $6.80 per long ton.]

Rank of officer occupying quarters.	Kind of range.	Number of rooms in house.	Average cost per month.	Mean temperature (outside).	Number pounds of coal per month.	Station.	Number of officers considered in each grade.	Cost per room per month.
				°F.				
Colonel	No. 5	11	$10.93	31.27	3,600	Fort Myer, Va.	1	$0.99
Lieutenant colonel	No. 4	12	12.92	31.00	4,290	Washington Barracks, D. C.	1	1.08
Major	do	12	9.52	31.00	3,144	do	3	.79
Do	No. 3	9	6.74	31.27	2,220	Fort Myer, Va.	2	.75
Do	do	7	10.54	31.27	3,465	do	1	1.51
Captain	do	10	8.50	31.27	2,805	do	1	.85
Do	do	9	10.20	31.27	3,360	do	1	1.13
Do	do	8	8.64	31.27	2,847	do	7	1.08
Do	do	10	7.62	31.00	2,504	Washington Barracks, D. C.	6	.75
First lieutenant	do	8	7.48	31.27	2,475	Fort Myer, Va.	1	.94
Do	do	7	8.77	31.27	2,886	do	6	1.25
Do	do	10	8.57	31.00	2,811	Washington Barracks, D. C.	3	.86
Second lieutenant	do	5	9.04	31.27	2,970	Fort Myer, Va.	1	1.81
Noncommissioned officer	No. 3a	5	5.98	31.27	1,965	do	7	1.20
Do	do	5	5.36	31.00	1,758	Washington Barracks, D. C.	12	1.07
Averages:								
Officers and noncommissioned officers		8.53	8.72		2,873			1.02
Officers only		9.00	9.19		3,029			1.02

Fuel allowances for officers and enlisted men on duty with or without troops and not occupying public quarters at stations within zones of equal temperature.

[Allowances per month are for the actual number of rooms occupied within the allowances given for each grade in Army Regulations 1044, based on anthracite coal at $7 per long ton with 1,700 pounds equivalent.]

[Values per month for number of rooms actually occupied.]

Number of rooms.	Months of—												
	December, January, and February.				March and November.				April, May, and October.			June, July, August, and September.	
	Zone 1, 0° to 20°.	Zone 2, 20° to 30°.	Zone 3, 30° to 40°.	Zone 4, 40° to 60°.	Zone 5, 10° to 25°.	Zone 6, 25° to 35°.	Zone 7, 35° to 45°.	Zone 8, 45° to 65°.	Zone 9, 35° to 40°.	Zone 10, 40° to 50°.	Zone 11, 50° to 70°.	Zone 12, 45° to 55°.	Zone 13, 55° to 75°.
10	$26.50	$24.50	$22.50	$20.50	$25.50	$23.50	$21.50	$18.00	$21.00	$20.00	$6.00	$19.00	$6.00
9	24.30	22.95	20.70	18.90	24.30	21.60	19.80	17.10	19.35	18.45	6.00	17.55	6.00
8	22.40	21.20	19.20	17.60	22.00	20.40	18.40	15.60	18.00	17.20	6.00	16.40	6.00
7	20.65	19.25	17.85	16.45	19.95	18.55	16.80	14.35	16.45	15.75	5.53	15.05	5.53
6	18.60	17.40	15.90	14.70	18.00	16.80	15.30	12.90	14.70	14.40	5.52	13.50	5.52
5	16.50	15.50	14.25	13.00	16.00	15.00	13.50	11.50	13.00	12.50	5.00	12.00	5.00
4	14.40	13.40	12.40	11.60	14.00	13.00	11.60	10.00	11.20	10.80	5.00	10.40	5.00
3	12.00	11.10	10.20	9.60	11.55	10.65	9.60	8.25	9.30	9.00	5.00	8.55	5.00
2	8.90	8.30	7.10	7.30	8.70	8.10	7.30	6.40	7.10	6.90	5.00	6.70	5.00
1	5.50	5.20	5.00	4.80	5.30	5.10	4.70	4.25	4.50	4.45	4.00	4.50	4.00

NOTE.—The allowances contained in the above table for the several zones of equal temperature are based on coal at $7 per ton, with a fuel equivalent of 1,700 pounds per cord of standard oak wood. At points other than within the vicinity of the city of Washington the cost of fuel will be different from that of $7 per ton and the equivalent of fuel used will also vary from 1,700 pounds per cord of standard oak wood. It will be necessary, therefore, in certain localities to apply a correction to the values given in the table. For this purpose the following equation should be used:

$$\text{Cost per month} = \frac{\text{Fuel equivalent of coal used}}{1{,}700} \times \frac{\text{Cost per long ton}}{\$7} \times \text{Table value for month in question.}$$

Fuel allowances for officers and enlisted men on duty with or without troops and not occupying public quarters at stations within zones of equal temperature.

[Allowances per room per month are for actual number of rooms occupied within the allowance given for each grade, based on anthracite coal at $7 per long ton with 1,700 pounds equivalent.]

Name of rank.	Number of rooms.	Months of—												
		December, January, and February.				March and November.				April, May, and October.			June, July, August, and September.	
		Zone 1, 0° to 20°.	Zone 2, 20° to 30°.	Zone 3, 30° to 40°.	Zone 4, 40° to 60°.	Zone 5, 10° to 25.°	Zone 6, 25° to 35°.	Zone 7, 35° to 45°.	Zone 8, 45° to 65°.	Zone 9, 35° to 40°.	Zone 10, 40° to 50°.	Zone 11, 50° to 70°.	Zone 12, 45° to 55°.	Zone 13, 55° to 75°
Lieutenant general	10	$2.65	$2.45	$2.25	$2.05	$2.55	$2.35	$2.15	$1.80	$2.10	$2.00	$0.60	$1.90	$0.60
Major general	9	2.70	2.55	2.30	2.10	2.70	2.40	2.20	1.90	2.15	2.05	.66⅔	1.95	.66⅔
Brigadier general	8	2.80	2.65	2.40	2.20	2.75	2.55	2.30	1.95	2.25	2.15	.75	2.05	.75
Colonel	7	2.95	2.75	2.55	2.35	2.85	2.65	2.40	2.05	2.35	2.25	.79	2.15	.79
Lieutenant colonel	6	3.10	2.90	2.65	2.45	3.00	2.80	2.55	2.15	2.45	2.40	.92	2.25	.92
Major	5	3.30	3.10	2.85	2.60	3.20	3.00	2.70	2.30	2.60	2.50	1.00	2.40	1.00
Captain	4	3.60	3.35	3.10	2.90	3.50	3.25	2.90	2.50	2.80	2.70	1.25	2.60	1.25
First lieutenant	3	4.00	3.70	3.40	3.20	3.85	3.55	3.20	2.75	3.10	3.00	1.66⅔	2.85	1.66⅔
Second lieutenant	2	4.45	4.15	3.55	3.65	4.35	4.05	3.65	3.20	3.55	3.45	2.50	3.35	2.50
Officer or enlisted man occupying 1 room	1	5.50	5.20	5.00	4.80	5.30	5.10	4.70	4.25	4.50	4.45	4.00	4.50	4.00

Comparison of present fuel allowances with the new allowances recommended in this report.

Grade.	Number of rooms.	Between 36° and 43° north latitude.					North of 43° north latitude.				
		Present annual allowance.	New annual allowance for warmest zone.	Annual decrease over present allowance.	New annual allowance for coldest zone.	Annual decrease over present allowance.	Present annual allowance.	New annual allowance for warmest zone.	Annual decrease over present allowance.	New annual allowance for coldest zone.	Annual decrease over present allowance.
Lieutenant general	10	$284.00	$152.50	$131.50	$198.50	$85.50	$301.36	$198.50	$102.86	$269.50	$31.86
Major general	9	264.00	143.70	120.30	184.65	79.35	280.00	184.65	95.35	249.75	30.25
Brigadier general	8	244.00	136.40	107.60	174.00	70.00	258.72	174.00	84.72	230.80	27.92
Colonel	7	224.00	125.86	98.14	160.02	63.98	237.36	160.02	77.34	211.40	25.96
Lieutenant colonel	6	204.00	116.94	87.06	146.58	57.42	216.00	146.58	69.42	189.90	26.10
Major	5	184.00	104.75	79.25	130.25	53.75	194.64	130.25	64.39	168.50	26.14
Captain	4	164.00	95.40	68.60	115.60	48.40	173.36	115.60	57.76	146.40	26.96
First lieutenant	3	136.00	84.80	51.20	98.90	37.10	144.00	98.90	45.10	121.20	22.80
Second lieutenant	2	116.00	70.90	45.10	78 20	37.80	122.64	78.20	44.44	91.90	30.74
Officer or enlisted man of any grade occupying 1 room	1	66.00	52.40	13.60	54.55	11.45	69.36	54.55	14.81	58.60	10.76
Temperature periods.	Zones.	10 rooms.	9 rooms.	8 rooms.	7 rooms.	6 rooms.	5 rooms.	4 rooms.	3 rooms.	2 rooms.	1 room.
December, January, and February	1	$79.50	$72.90	$67.20	$61.95	$55.80	$49.50	$43.20	$36.00	$26.70	$16.50
Do	2	73.50	68.85	63.60	57.75	52.20	46.50	40.20	33.30	24.90	15.60
Do	3	67.50	62.10	57.60	53.55	47.70	42.75	37.20	30.60	21.30	15.00
Do	4	61.50	56.70	52.80	49.35	44.10	39.00	34.80	28.80	21.90	14.40
March and November	5	51.00	48.60	44.00	39.90	36.00	32.00	28.00	23.10	17.40	10.60
Do	6	47.09	43.20	40.80	37.10	33.60	30.00	26.00	21.30	16.20	10.20
Do	7	43.00	39.60	36.80	33.60	30.60	27.00	23.20	19.20	14.60	9.40
Do	8	36.00	34.20	31.20	28.70	25.80	23.00	20.00	16.50	12.80	8.50
April, May, and October	9	63.00	58.05	54.00	49.35	44.10	39.00	33.60	27.90	21.30	13.50
Do	10	60.00	55.35	51.60	47.25	43.20	37.50	32.40	27.00	20.70	13.35
Do	11	18.00	18.00	18.00	16.59	16.56	15.00	15.00	15.00	15.00	12.00
June, July, August, and September	12	76.09	70.20	65.60	60.20	54.00	48.00	41.60	34.20	26.80	18.00
Do	13	24.00	24.00	24.00	22.12	22.08	20.00	20.00	20.00	20.00	16.00

Maximum money values of the present fuel allowances under Army Regulations, 1044, for the zones as established therein and computed on the quantities of hardwood at $4 per cord as prescribed in said paragraph.

Grade.	Number of rooms.	Zone 1 (Tropics year round).				Zone 2 (between thirty-sixth and forty-third degree north latitude).						Zone 3 (north of forty-third degree north latitude).					
						May 1 to Aug. 31 (4 months).		Sept. 1 to Apr. 30 (8 months).				May 1 to Aug. 31 (4 months).		Sept. 1 to Apr. 30 (8 months).			
		Per month.	Per room.	Total cost per year (12 months).	Average cost per room per month.	Per month.	Per room.	Per month.	Per room.	Total cost per year (12 months).	Average cost per room per month.	Per month.	Per room.	Per month.	Per room.	Total cost per year (12 months).	Average cost per room per month.
Lieutenant general	10	$6.00	$0.69	$72.00	$0.60	$6.00	$0.60	$32.50	$3.25	$284.00	$2.36⅔	$6.00	$0.60	$34.67	$3.47	$301.36	$2.511
Major general or officer of higher rank occupying 9 rooms as quarters	9	6.00	.66⅔	72.00	.66⅔	6.00	.66⅔	30.00	3.33⅓	264.00	2.44⅜	6.00	.66⅔	32.00	3.56	280.00	2.592
Brigadier general or officer of higher rank occupying 8 rooms as quarters	8	6.00	.75	72.00	.75	6.00	.75	27.50	3.44	244.00	2.54⅛	6.00	.75	29.34	3.67	258.72	2.695
Colonel or officer of higher rank occupying 7 rooms as quarters	7	6.00	.85	72.00	.85	6.00	.85	25.00	3.57	224.00	2.66⅔	6.00	.85	26.67	3.81	237.36	2.825
Lieutenant colonel or officer of higher rank occupying 6 rooms as quarters	6	6.00	1.00	72.00	1.00	6.00	1.00	22.50	3.75	204.00	2.83⅓	6.00	1.00	24.00	4.00	216.00	3.000
Major or officer of higher rank occupying 5 rooms as quarters	5	6.00	1.20	72.00	1.20	6.00	1.20	20.00	4.00	184.00	3.06⅔	6.00	1.20	21.33	4.27	194.64	3.244
Captain or officer of higher rank occupying 4 rooms as quarters	4	6.00	1.50	72.00	1.50	6.00	1.50	17.50	4.37½	164.00	3.41½	6.00	1.50	18.67	4.67	173.36	3.611
First lieutenant or officer of higher rank occupying 3 rooms as quarters	3	4.00	1.33	48.00	1.33	4.00	1.33	15.00	5.00	136.00	3.77⅔	4.00	1.33	16.00	5.33	144.00	4.000
Second lieutenant or officer of higher rank occupying 2 rooms as quarters	2	4.00	2.00	48.00	2.00	4.00	2.00	12.50	6.25	116.00	4.83⅓	4.00	2.00	13.33	6.67	122.64	5.110
Officer of any rank occupying 1 room as quarters	1	4.00	4.00	48.00	4.00	4.00	4.00	6.25	6.25	66.00	5.50	4.00	4.00	6.67	6.67	69.36	5.780

The variation in the average cost per room per month can be readily accounted for for the reason that the cost of heating per room is not in direct proportion to the number of rooms and the amount of fuel used for cooking is practically the same for all grades. These facts are clearly shown by a study of the data obtained at recent tests appended hereto.

AMENDMENTS TO ARMY REGULATIONS NECESSARY TO CARRY INTO EFFECT THE RECOMMENDATIONS MADE IN THE PRECEDING REPORT RELATIVE TO THE ISSUE OF FUEL.

Army Regulations, 1036, to be amended to read as follows:

1036. Each officer or enlisted man entitled to and occupying public quarters will be furnished at the expense of the United States with the quantity of fuel necessary to properly heat the building to which assigned at a military post in accordance with fuel charts published in orders from time to time. This allowance will be calculated from the fuel charts monthly, and any excess of allowance appearing as overdrawn by an officer or enlisted man at the end of any month will be paid for at contract price. Where an officer or enlisted man is occupying quarters other than public, heated by a separate plant, the Quartermaster Corps will reimburse such officer or enlisted man for the fuel actually necessary for the number of rooms actually occupied, but not exceeding the number to which the rank of the officer or enlisted man entitles him as specified in A. R., 1044, and in no case exceeding the maximum allowances set forth in the following table for the zones of equal temperature in which serving, charts showing zones of equal temperature to be published in orders from time to time.

Fuel allowances for officers and enlisted men on duty with or without troops, and not occupying public quarters at stations within the zones of equal temperature given below, will be as follows: Allowances per month for the actual number of rooms occupied within the allowances given for each grade in Army Regulations, 1044 (based on anthracite coal at $7 per long ton with 1,700 pounds equivalent):

[Values per month for number of rooms actually occupied.]

Number of rooms.	Months of—												
	December, January, and February.				March and November.				April, May, and October.			June, July, August, and September.	
	Zone 1, 0° to 20°.	Zone 2, 20° to 30°.	Zone 3, 30° to 40°.	Zone 4, 40° to 60°.	Zone 5, 10° to 25°.	Zone 6, 25° to 35°.	Zone 7, 35° to 40°.	Zone 8, 45° to 65°.	Zone 9, 35° to 40°.	Zone 10, 40° to 50°.	Zone 11, 50° to 70°.	Zone 12, 45° to 55°.	Zone 13, 55° to 75°.
10	$26.50	$24.50	$22.50	$20.50	$25.50	$23.50	$21.50	$18.00	$21.00	$20.00	$6.00	$19.00	$6.00
9	24.30	22.95	20.70	18.90	24.30	21.60	19.80	17.10	19.35	18.45	6.00	17.55	6.00
8	22.40	21.20	19.20	17.60	22.00	20.40	18.40	15.60	18.00	17.20	6.00	16.40	6.00
7	20.65	19.25	17.85	16.45	19.95	18.55	16.80	14.35	16.45	15.75	5.53	15.05	5.53
6	18.60	17.40	15.90	14.70	18.00	16.80	15.30	12.90	14.70	14.40	5.52	13.50	5.52
5	16.50	15.50	14.25	13.00	16.00	15.00	13.50	11.50	13.00	12.50	5.00	12.00	5.00
4	14.40	13.40	12.40	11.60	14.00	13.00	11.60	10.00	11.20	10.80	5.00	10.40	5.00
3	12.00	11.10	10.20	9.60	11.55	10.65	9.60	8.25	9.30	9.00	5.00	8.55	5.00
2	8.90	8.30	7.10	7.30	8.70	8.10	7.30	6.40	7.10	6.90	5.00	6.70	5.00
1	5.50	5.20	5.00	4.80	5.30	5.10	4.70	4.25	4.50	4.45	4.00	4.50	4.00

NOTE.—The allowances contained in the above table for the several zones of equal temperature are based on coal at $7 per ton, with a fuel equivalent of 1,700 pounds per cord of standard oak wood. At points other than within the vicinity of the city of Washington the cost of fuel will be different from that of $7 per ton, and the equivalent of fuel used will also vary from 1,700 pounds per cord of standard oak wood. It will be necessary, therefore, in certain localities to apply a correction to the values given in the table. For this purpose the following equation should be used:

$$\text{Cost per month} = \frac{\text{Fuel equivalent of coal used}}{1{,}700} \times \frac{\text{Cost per long ton}}{\$7} \times \text{Table value for month in question.}$$

When an officer or enlisted man is occupying quarters other than public, not heated by a separate plant, the Quartermaster Corps will reimburse such officer or enlisted man for the fuel furnished for the number of rooms actually occupied, but not exceeding the number to which the rank of the officer or enlisted man entitles him as set forth in A. R., 1044, at the rate given for the zone of equal temperature in which serving.

Where an officer or enlisted man is on detached service in a foreign country and occupying quarters other than public, the Quartermaster Corps will reimburse such officer or enlisted man for the value of the fuel actually necessary for the number of rooms actually occupied, but not exceeding the number to which the rank of the officer or enlisted man entitles him as set forth in A. R., 1044, and not exceeding the maximum allowances given for the zones of equal temperature established and published in orders from time to time.

1041. An officer may draw from the Quartermaster Corps a reasonable quantity of fuel and kindling wood, which will be issued on the basis of its equivalent in oak wood and charged as part of the allowance provided on fuel charts for the building concerned.

1044. The following table shows the number of rooms, and the allowance of cooking and heating stoves to be supplied for the use of officers and men in quarters and barracks:

	Rooms.		For quarters.		For office.
	As quarters.	As office.	Heating stoves.	Cooking stoves or ranges.	Heating stoves.
Lieutenant general	10	.....	9	1	.....
Major general or officer of higher rank occupying 9 rooms as quarters	9	.....	8	1	.....
Brigadier general or officer of higher rank occupying 8 rooms as quarters	8	.....	7	1	.....
Colonel or officer of higher rank occupying 7 rooms as quarters	7	.....	6	1	.....
Lieutenant colonel or officer of higher rank occupying 6 rooms as quarters	6	.....	5	1	.....
Major or officer of higher rank occupying 5 rooms as quarters	5	.....	4	1	.....
Captain or officer of higher rank occupying 4 rooms as quarters	4	.....	3	1	.....
First lieutenant or officer of higher rank occupying 3 rooms as quarters	3	.....	2	1	.....
Second lieutenant or officer of higher rank occupying 2 rooms as quarters	2	.....	1	1	.....
Officer of any rank occupying 1 room as quarters	1	.....	1	.....	.....
The Chief of Staff of the Army	.....	3	.....	.....	3
The commanding general of a department, brigade, or district	.....	2	.....	.....	2
An assistant to the Chief of Staff of the Army, the aids to the commanding general of a department, brigade, or district, and the general staff officers serving thereat	.....	1	.....	.....	1
A colonel or lieutenant colonel, Quartermaster Corps; a colonel, Medical Department; and the department quartermaster at the headquarters of a territorial department, each	.....	2	.....	.....	2
The commanding officer of a regiment, post, or battalion of Engineers or Field Artillery, quartermaster and adjutant, each	.....	1	.....	.....	1
An adjutant general, an inspector general, an acting inspector general, an engineer,[1] an ordnance officer,[1] a signal officer, a judge advocate or an acting judge advocate, and the senior medical officer, when stationed on duty at any place not in the field,[1] each	.....	1	.....	.....	1
Noncommissioned officers above grade number 16, paragraph 9, principal musicians, chief trumpeters, and firemen, Coast Artillery Corps, each	1	.....	1	.....	.....
Noncommissioned officers below grade 15, paragraph 9, and privates, when on detached service or assigned to special duty of such a nature as to necessitate the hiring or leasing of quarters, each	1	.....	1	.....	.....
Superintendent national cemetery	.....	.....	.....	1	.....

	Rooms.		For quarters.		For office.
	As quarters.	As office.	Heating stoves.	Cooking stoves or ranges.	Heating stoves.
Each noncommissioned officer, musician, private, and hospital matron					
Each necessary fire for the sick in hospital, each dispensary and hospital mess room at a military post or station, to be regulated by the surgeon and commanding officer, not exceeding			1		
For general hospitals, when necessary, not exceeding for each bed					
Each guard fire, to be regulated by the commanding officer, not exceeding			1		
Each necessary fire for military courts or boards, at a rate not exceeding			1		
Storehouse of a quartermaster, when necessary, not exceeding, for each			1		
Each employee of the Quartermaster Corps or Medical Department to whom subsistence in kind is issued by the Government					
For library, reading room, schoolroom, chapel, and gymnasium, 1 heating stove for each, and when the garrison exceeds 150 enlisted men, 2 heating stoves, and such quantity of fuel for the same as may be certified to as necessary by the officers in charge and approved by the commanding officer					
For a company: 2 large stoves in dormitory, 1 large stove in each mess room and day room, 1 small stove for each of the two rooms for noncommissioned officers, 1 small stove for the library, and 1 cooking stove or range sufficient to cook its food					
Each hospital kitchen				1	
For each authorized room as quarters for civilian employees			1		
For each 6 civilian employees to whom fuel is allowed			1		
For mess of civilian employees				1	
For telegraph office			1		
For each blacksmith, carpenter, and saddler shop			1		
For a bakery and post exchange such quantity of fuel for the same as may be certified to as necessary by the officers in charge and approved by the commanding officer					

[1] Except at Military Academy.

1. The allowance of fuel for heating, cooking, and heating water in barracks and quarters at military posts will be determined in accordance with fuel charts and table of allowances published in orders from time to time.

1049. To be rescinded.

1006 To be rescinded

DRAFT OF PROPOSED GENERAL ORDER RELATIVE TO THE ISSUE OF FUEL AT MILITARY POSTS.

In accordance with paragraph 1044, Army Regulations, 1913 (amended), the following instructions relative to the issue of fuel at military posts will be carried out:

1. The post quartermaster will keep a definite and accurate account of the amount of fuel of all kinds that is received and issued to the several buildings at a military post. With a view to assisting the post authorities in the receiving, issuing, and supervising the use of fuel at army posts, a noncommissioned officer of suitable grade, Quartermaster Corps, will be designated, whose duties will be to receive and supervise the issue and use of fuel in all buildings at the post, under the supervision of the Quartermaster.

2. There will be assigned to each public building or group of buildings a competent enlisted man for the purpose of handling the heating apparatus installed in that building or group of buildings. In the case of company or detachment barracks, a company fireman will be detailed and will be required to keep a daily record of the amount of coal used and the temperature of the squad rooms in such building. The enlisted man so assigned, in charge of the heating apparatus, will be changed as infrequently as possible, and should be selected because of his trustworthiness and special fitness for the work. Organization commanders and officers responsible for buildings will be required to make at the time of their regular inspections prescribed in existing regulations, an inspection of the heating apparatus installed in such buildings, and in the case of company or detachment barracks, some responsible noncommissioned officer of the organization will be required to supervise daily the matter of proper and economical use of fuel, the daily removal of ashes from ash pits, and the cleaning of flues.

3. Greater interest and economy in the use of fuel will be obtained in requiring the company firemen to keep a daily record of the amount of coal used and the temperature of the squad rooms in each building, if company and other commanders at the time of their periodical inspections will inquire relative to the amount of fuel used.

4. An accurate and definite account of the amount of fuel of all kinds issued to a building will be kept by the noncommissioned officer, Quartermaster Corps, detailed at each post to assist the post authorities in this matter. A receipt will be given the post quarter-

master for all fuel issued to any building by the responsible officer or enlisted man. This account will be checked frequently and the instant any building appears to have drawn more fuel than allowed by the fuel charts provided in this order for the proper and economical firing of the boilers in such building, a report will be made to the post commander, with a view to having the matter investigated and definitely determining the reason for such apparent excessive use of fuel.

5. The noncommissioned officer, Quartermaster Corps, designated to supervise the use of fuel at military posts, will be required to make periodical (daily, if possible) inspections of heating plants and other apparatus for which fuel is issued at a military post, to see that they are properly fired and that the instructions relative to their use are being complied with.

6. For the firing of heating boilers in officers' quarters and messes at a military post, there will be assigned a sufficient number of enlisted men to properly care for such heating apparatus. This detachment will be in charge of a noncommissioned officer of suitable rank, who will be responsible for the proper use of fuel in such buildings.

7. The issue of fuel at military posts and stations will be based—

First. Upon the area in square feet of grate on which the fuel is burned.

Second. The average outside temperature during the time such fuel is burned.

Third. On a factor which takes into account the human element, or those charged with the operation of such apparatus.

8. There are appended hereto, as part of this order, two sets of charts—the first set being a tabulation of temperatures from which a mean temperature for each post has been determined; the second are coal-consumption charts which have been prepared for various minimum temperatures from plus 40° to minus 40°, at 10° intervals, and the allowable rate of combustion at any intermediate (average temperature) between 70° and the minimum on any chart is directly interpolated. These charts show the allowable coal consumption per square foot of grate area at the several posts for steam and hot-water boilers.

9. The two sets of charts above referred to will be used to determine the amount of coal allowed for any building. To illustrate this method, the following example is given:

Referring to Chart No. 5, on which chart appears, among other posts, Fort Myer, Va., assuming the building in question to be equipped with a Century boiler of 2,200 feet capacity, with $10\frac{1}{2}$ square feet of grate area, the allowance of coal for the month of January would be determined as follows:

Referring to temperature table, it will be seen that the average temperature for the month of January is 35°. Interpolating on the

coal charts at 35°, it will be found that 3 pounds of coal per square foot of grate area is the proper amount to be used for the boiler in question. The total allowance for the month would then be determined as follows:

$$\frac{3 \text{ pounds} \times 24 \text{ hours} \times 31 \text{ days} \times 10.5 \text{ square feet}}{2{,}240 \text{ pounds.}} = 10.45 \text{ tons for the month of January.}$$

10. The above calculations are based on the assumption that the standard coal of 1,800 pounds equivalent per cord of oak wood is used. This may not be the case at other posts, and if the coal has a different fuel equivalent it will be necessary to apply a correction for this difference of equivalents. The manner of making this correction is as follows:

It was previously found that 10.45 tons of coal having an equivalent of 1,800 pounds per cord of oak wood was the proper allowance for the month of January. Assuming that the coal used instead of having an equivalent of 1,800 pounds had an equivalent of 1,675 pounds, the correct allowance would then be:

$$\frac{1675}{1800} \times 10.45 = 9.67 \text{ tons}$$

as the correct allowance for the month of January.

11. It will readily be seen that for each building in question the post quartermaster would work out the allowance for each month and tabulate it for ready reference. Should the amount of coal issued and used in any building be exceeded at any time during the period in question, it would clearly indicate that those in charge of the heating apparatus are not obtaining the best results in the use of such apparatus, and that the fuel in question is not being economically used.

12. The allowances for Tabasco hot-water heaters or heaters of equal capacity can be determined from the fuel charts in a similar manner. The allowances for the following Tabasco hot-water heaters in the service have been determined and will apply.

	Heater.			
	No. 150, 17 and 18.	No. 200, 21 and 22.	No. 300, 25, 26, and 27.	No. 500, 30.
Grate areas.....square feet..	[1] 0.7854	0.7855–1.40	1.41–2.18	2.19–3.40
Coal allowance.....pounds per month..	3,000	4,000	7,000	9,000

[1] And less.

These allowances are based on the assumption that anthracite and good coking bituminous coals are used. Should any other coals be used, corrections of the amounts above indicated should be made in accordance with the method outlined in the tenth paragraph above.

13. The allowances of fuel for cooking and heating water in barracks and other buildings at military posts and for the several types of ranges used will be as follows:

Army ranges:

Nos. 1, 2, 6 (old), 3, 3a, not exceeding 2,500 pounds per month.
Nos. 4a (old), 5 single, 4,500 pounds per month.
Nos. 4 (old), and 5 double, 6,000 pounds per month.

These allowances are based on the assumption that anthracite and good coking bituminous coals are used. For any other type of fuel, the formula given in paragraph 10 above should be used to determine the correct amount needed.

14. The issue of fuel in kind will only be made at military posts and stations.

15. In accordance with the provisions of Army Regulations, 1036, the following charts showing zones of equal temperature are appended hereto and made part of this order.

16. In accordance with the provisions of Army Regulations, 1036, in so far as that paragraph relates to the reimbursement of officers and enlisted men on detached service in foreign cities and occupying quarters other than public, allowances for the zones of equal temperature established and previously referred to will be as follows:

	Zone No.
Mexico City, Mexico:	
December, January, February	3
March, November	7
April, May, October	10
June, July, August, September	13
Berne, Switzerland:	
December, January, February	1
March, November	5
April, May, October	10
June, July, August, September	12
Stockholm, Sweden:	
December, January, February	1
March, November	5
April, May, October	9
June, July, August, September	12
Berlin, Germany:	
December, January, February	1
March, November	5
April, May, October	10
June, July, August, September	12
Constantinople, Turkey:	
December, January, February	2
March, November	6
April, May, October	10
June, July, August, September	13
Vienna, Austria:	
December, January, February	1
March, November	5
April, May, October	10
June, July, August, September	12

	Zone No.
Peking, China:	
December, January, February	1
March, November	5
April, May, October	10
June, July, August, September	12
Brussels, Belgium:	
December, January, February	1
March, November	6
April, May, October	10
June, July, August, September	12
London, England:	
December, January, February	1
March, November	6
April, May, October	10
June, July, August, September	12
St. Petersburg, Russia:	
December, January, February	1
March, November	5
April, May, October	9
June, July, August, September	12
Santiago de Cuba: For the year round	13
Tokyo, Japan:	
December, January, February	2
March, November	7
April, May, October	10
June, July, August, September	12
Paris, France:	
December, January, February	2
March, November	7
April, May, October	10
June, July, August, September	12
Quito, Ecuador:	
December, January, February	3
March, November	8
April, May, October	11
June, July, August, September	13
Madrid, Spain:	
December, January, February	2
March, November	7
April, May, October	10
June, July, August, September	12
Rome, Italy:	
December, January, February	2
March, November	6
April, May, October	11
June, July, August, September	13
Monrovia, Liberia: For the year round	13
Rio de Janeiro, Brazil: For the year round	13
Lima, Peru: For the year round	13

Posts.	1899				1900				Mean.
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	
Adams, R. I.	61	52	41	34	29	29	33	46	40
Alcatraz, Cal.	58	59	56	49	50	53	55	54	54
Allegheny, Pa.	65	59	46	33	34	29	34	52	44
Andrews, Mass.	62	54	42	36	30	29	34	48	42
Apache, Ariz.	69	56	47	36	39	39	52	52	48
Armistead, Md.	67	58	47	37	36	33	38	55	46
Assinniboine, Mont.	58	40	40	20	27	11	31	49	34
Augusta, Ga.	74	65	56	45	44	46	53	64	56
Baker, Cal.	58	59	56	49	50	53	55	54	54
Banks, Mass.	62	54	42	36	30	29	34	48	42
Barrancas, Fla.	77	70	62	53	51	52	59	66	61
Bayard, N. Mex.	68	54	48	40	43	42	50	47	49
Benicia, Cal.	58	59	56	49	50	53	55	54	54
Bliss, Tex.	75	63	54	44	47	48	58	59	56
Boise, Idaho.	65	48	46	30	36	36	48	51	45
Brady, Mich.	50	47	37	19	20	12	17	43	30
Brown, Tex.	80	72	70	59	57	68	72	67	67
Ben Harrison, Ind.	65	60	46	29	33	26	35	52	43
Carroll, Md.	67	58	47	37	36	33	38	55	46
Casey, Wash.	58	50	51	44	43	42	48	50	48
Caswell, N. C.	75	68	58	49	48	46	52	63	57
Clark, Tex.	80	71	58	49	51	52	60	67	53
Columbia, Wash.	61	51	52	44	45	43	51	52	49
Columbus, Ohio.	65	59	45	31	32	26	34	51	43
Constitution, N. H.	58	50	37	31	23	23	28	43	36
Crook, Nebr.	66	59	46	25	29	17	36	55	41
Crockett, Tex.	76	70	59	49	49	48	57	65	59
Dade, Fla.	79	74	67	61	57	59	64	70	66
D. A. Russell, Wyo.	59	43	40	29	31	24	35	40	37
Davis, Alaska.									
Des Moines, Iowa.	64	59	45	23	27	17	33	54	40
De Soto, Fla.	79	74	67	61	57	59	64	70	66
Douglas, Utah.	67	49	46	29	35	34	48	49	44
Duchense, Utah.	63	44	36	13	16	24	42	48	35
Du Pont, Del.	63	55	43	34	32	30	36	51	43
Egbert, Alaska.	40	20	−10	− 7	−24	− 6	13	29	7
Ethan Allen, Vt.	60	53	38	30	22	22	23	44	36
Flagler, Wash.	58	50	51	44	43	42	48	50	48
Foster, N. H.	58	50	37	31	23	23	28	43	36
Frankford, Pa.	67	58	46	37	34	32	37	53	45
Fremont, S. C.	78	70	61	52	51	49	57	67	60
Gibbons, Alaska.	43	30	21	11	− 6	16	10	17	18
Grant, Ariz.									
Greble, R. I.	61	52	41	34	29	29	33	46	40
Hamilton, N. Y.	65	58	45	36	33	31	35	51	44
Hancock, N. J.	65	56	44	36	32	31	35	50	43
Harrison, Mont.	59	41	40	25	31	21	38	47	38
Heath, Mass.	62	54	42	36	30	29	34	48	42
H. G. Wright, N. Y.	61	56	43	35	29	26	34	49	41
Hot Springs, Ark.	73	67	56	45	44	41	54	61	55
Howard, Md.	67	58	47	37	36	33	38	55	46
Huachuca, Ariz.	76	60	52	46	48	47	55	54	54
Hunt, Va.	65	58	45	36	35	33	38	54	45
Jackson Barracks, La.	77	71	63	54	52	53	61	68	62
Jay, N. Y.	65	58	45	36	33	31	35	51	45
Jefferson Barracks, Mo.	70	64	52	33	37	29	42	58	48
Jeffersonville Depot.	69	60	48	34	36	31	41	55	47
Keogh, Mont.	61	43	40	21	29	16	34	53	37
Key West Barracks, Fla.	82	78	74	71	66	68	70	74	73
Kennebec Arsenal, Me.	57	49	35	29	22	23	29	47	36
Lawton, Wash.	61	51	51	44	43	42	49	51	49
Leavenworth, Kans.	67	63	49	28	34	23	39	56	45
Levett, Me.	57	50	37	32	23	23	28	45	37
Lincoln, N. Dak.	57	43	37	14	18	− 3	22	50	29
Liscum, Alaska.	49	35	29	14	14	23	31	35	28
Logan H. Roots, Ark.	72	66	55	41	44	10	52	63	54
Logan, Colo.	65	49	44	30	36	30	42	44	42
Mackenzie, Wyo.	61	42	39	23	25	20	35	41	36
Madison Barracks, N. Y.	59	52	36	28	21	20	21	44	35
Mansfield, R. I.	60	53	40	33	29	27	32	46	40
Mason, Cal.	58	59	56	49	50	53	55	54	54
McDowell, Cal.	58	59	56	49	50	53	55	54	54
McHenry, Md.	67	58	47	37	36	33	38	55	46
McIntosh, Tex.	80	75	65	54	56	57	66	72	65
McKinley, Me.	57	50	37	32	23	23	28	45	37
McPherson, Ga.	71	63	54	42	43	41	50	62	46
McRee, Fla.	77	70	62	53	51	52	59	66	61
Meade, S. Dak.	62	47	41	24	32	18	32	50	38
Michie, N. Y.	61	56	43	35	29	26	34	49	41
Miley, Cal.	58	59	56	49	50	53	55	54	54
Missoula, Mont.	59	43	39	28	29	26	42	50	39

Posts.	1899				1900				Mean.
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	
Monroe, Va.	71	63	52	42	42	40	45	56	51
Morgan, Ala.	76	69	61	51	49	51	58	66	60
Mott, N. J.	66	58	45	37	34	32	38	53	45
Moultrie, S. C.	76	68	61	51	49	49	56	65	59
Myer, Va.	65	58	45	36	35	33	38	54	45
New York Arsenal, N. Y.	65	58	45	36	33	31	35	51	44
Niagara, N. Y.	60	55	42	31	27	23	25	43	38
Niobrara, Nebr.	63	49	41	29	30	20	33	50	38
Oglethorpe, Ga.	70	63	53	40	40	39	48	61	52
Omaha, Nebr.	66	59	46	25	29	17	36	55	41
Ontario, N. Y.	59	53	40	30	25	23	24	43	38
Pickens, Fla.	77	70	62	53	51	52	59	66	61
Plattsburg Barracks, N. Y.	62	50	36	27	19	18	22	44	35
Porter, N. Y.	60	55	42	31	27	23	25	43	38
Preble, Me.	57	50	37	32	23	23	28	45	37
Presidio Monterey, Cal.	62	60	55	52	52	53	55	55	55
Presidio San Francisco, Cal.	58	59	56	49	50	53	55	54	54
Reno, Okla.	73	65	52	36	39	38	50	60	52
Revere, Mass.	62	54	42	36	30	29	34	48	42
Riley, Kans.	70	64	51	30	27	20	38	51	44
Ringgold, Tex.	76	68	54	40	45	42	54	59	54
Robinson, Nebr.	60	43	42	26	33	21	34	47	38
Rock Island Arsenal, Ill.	63	58	44	26	28	17	29	50	39
Rodman, Mass.	61	55	43	35	32	30	24	47	42
Rosecrans, Cal.	65	62	60	58	57	57	59	56	59
Sam Houston, Tex.	78	72	61	53	53	54	61	67	62
San Antonio, Tex.	78	72	61	53	53	54	61	67	62
Sandy Hook, N. J.	64	56	45	36	32	31	36	49	43
Schuyler, N. Y.	65	58	45	36	32	31	35	51	44
Screven, Ga.	76	68	61	50	49	50	57	67	59
Sequoia National Park.	75	60	54	43	46	49	57	55	54
Sheridan, Ill.	62	58	44	27	28	20	29	46	39
Sill, Okla.	76	69	55	40	42	38	52	62	54
Slocum, N. Y.	65	58	45	36	32	31	35	51	44
Smallwood, Md.	67	58	47	37	36	33	38	55	46
Snelling, Minn.	59	52	40	21	21	8	25	52	34
Springfield, Mass.	61	53	40	32	28	27	31	47	40
Stark, N. H.	58	50	37	31	23	23	28	43	36
Standish, Mass.	62	54	42	36	30	29	34	48	42
Stevens, Oreg.	60	53	52	45	44	42	48	49	49
St. Michael, Alaska.	43	30	21	11	− 6	16	10	17	18
St. Philip, La.	77	71	63	51	52	53	61	68	62
Strong, Mass.	62	54	42	36	30	29	34	48	42
Sumter, S. C.	76	68	61	51	49	49	56	65	59
Terry, N. Y.	61	56	43	35	29	26	34	49	41
Thomas, Ky.	68	60	48	33	35	29	38	54	45
Totten, N. Y.	65	58	45	36	32	31	35	51	44
Trumbull, Conn.	61	56	43	35	29	26	34	49	41
United States Powder Depot, N. J.									
Vancouver Barracks, Wash.	61	50	51	42	42	41	51	51	48
Wadsworth, N. Y.	65	58	45	36	33	31	35	51	44
Walla Walla, Wash.	67	51	49	37	41	37	51	52	48
Ward, Wash.	61	51	51	44	43	42	49	51	49
Warren, Mass.	62	54	42	36	30	29	34	48	42
Washakie, Wyo.	58	41	37	19	28	18	37	42	35
Washington Barracks, D. C.	65	58	45	36	35	33	38	54	45
Washington, Md.	65	58	45	36	35	33	38	54	45
Watertown Arsenal, Mass.	62	54	42	36	30	29	34	48	42
Watervliet Arsenal, N. Y.	61	53	39	32	26	25	27	48	39
Wayne, Mich.	59	56	42	28	28	21	26	48	38
West Point, N. Y.	60	51	38	31	27	25	30	46	38
Wetherill, R. I.	61	52	41	34	23	29	33	46	40
Whipple Barracks, Ariz.	69	52	45	30	40	40	48	45	47
W. H. Seward, Alaska.	51	35	23	18	23	29	35	35	31
Williams, Me.	57	50	37	32	23	23	38	45	38
Wingate, N. Mex.	66	51	42	36	27	37	44	42	43
Wood, N. Y.	65	58	45	36	33	31	35	51	44
Worden, Wash.	58	50	51	44	43	42	48	50	48
Wright, Wash.	62	46	45	33	35	31	45	51	43
Yosemite National Park.	54	37	35	18	22	15	34	42	32
Yellowstone, Wyo.	54	37	35	18	22	15	34	42	32

Mean minimum temperatures.

[U. S. Department of Agriculture, Weather Bureau.]

Stations.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
Porto Rico:													
Cayey (1908-1913)	59	58	58	60	63	66	65	66	65	63	62	60	62
Mayaguez (1908-1913)	62	61	61	62	65	66	66	68	68	68	68	64	65
Ponce (1908-1913)	65	65	66	67	70	72	72	72	72	70	69	66	69
San Juan (1899-1910)	70	70	70	72	73	74	75	75	75	74	73	71	73
Hawaii:													
Schofield Barracks (1909-1913)	59	59	59	61	61	63	64	65	65	63	62	61	62
Honolulu	65	66	66	67	69	70	72	73	72	72	69	66	69
Alaska:													
Tanana (Fort Gibbon)	−25	−16	− 7	10	31	45	48	40	30	14	−10	−20	12
Eagle (Fort Egbert)	−29	−20	− 4	12	32	46	48	43	30	15	− 6	−20	12
Nome (Fort Davis)	− 6	− 4	− 5	8	29	38	44	45	36	24	10	0	18
St. Michael (Fort St. Michael)	− 5	− 1	0	9	25	38	48	47	39	28	12	− 1	20

REMARKS.—Elevations: Cayey, 1,350 feet above sea level; Mayaguez, 80; Ponce, 80; San Juan, 50; Schofield Barracks, 990; Honolulu, 111; Tanana, 200; Eagle, 573; St. Michael, about 30 feet.

Comparison of daily allowance of fuel.

[Based on proposed new chart allowances and on Army Regulations.]

	Proposed allowance.			Allowance from Army Regulations.		
	Heating.	Cooking.	Total.	Heating.	Cooking.	Total.
−20° temperature allowance chart for certain posts north of 43° north latitude:						
Colonel	226	150	376	293	85	378
Major	185	85	270	217	85	302
Captain	159	85	244	180	85	265
Lieutenant	136	85	221	170	57	227
Noncommissioned officer	90	75	165	47	28	75
Barrack	722			1,277		
±0° temperature allowance chart for certain posts between 36° and 43° north latitude:						
Colonel	185	150	335	269	85	354
Major	159	85	244	198	85	283
Captain	136	85	221	160	85	245
Lieutenant	114	85	199	156	57	213
Noncommissioned officer	75	75	150	43	28	71
Barrack	632			933		
+20° temperature allowance chart, for certain posts south of 36° north latitude:						
Colonel	97	150	247	198	85	283
Major	83	85	168	142	85	227
Captain	70	85	155	113	85	198
Lieutenant	70	85	155	113	57	170
Noncommissioned officer	40	75	115	29	28	57
Barrack	357			533		

Figures on table are pounds of coal per day.

Areas of heating boiler grates.

CENTURY AND IDEAL.

[Kewanee Boiler Co. and American Radiator Co.]

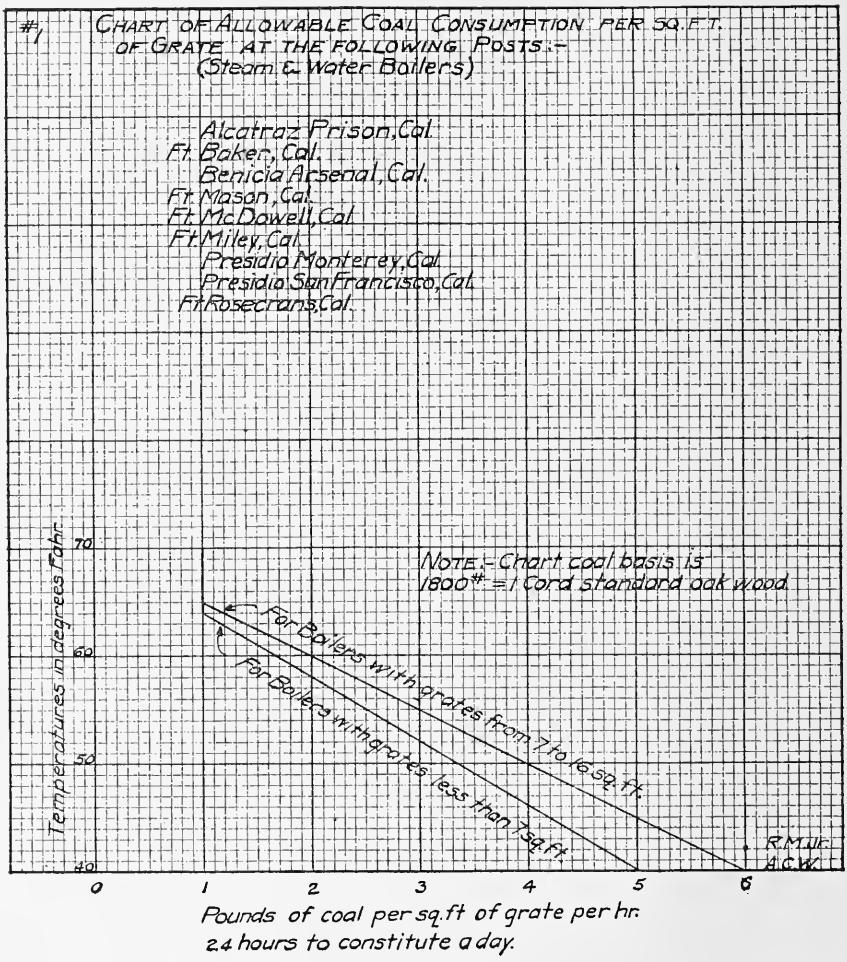
	Capacity in radiation, square feet.		Grate area in square feet.
	Steam.	Water.	
No. 12	1,200	2,000	6.25
No. 15	1,500	2,500	7.50
No. 18	1,800	3,000	8.75
No. 22	2,200	3,600	10.50
No. 26	2,600	4,300	12.25
No. 30	3,000	5,000	14.00
No. 36	3,600	6,000	15.75
No. 45	4,500	7,500	17.50

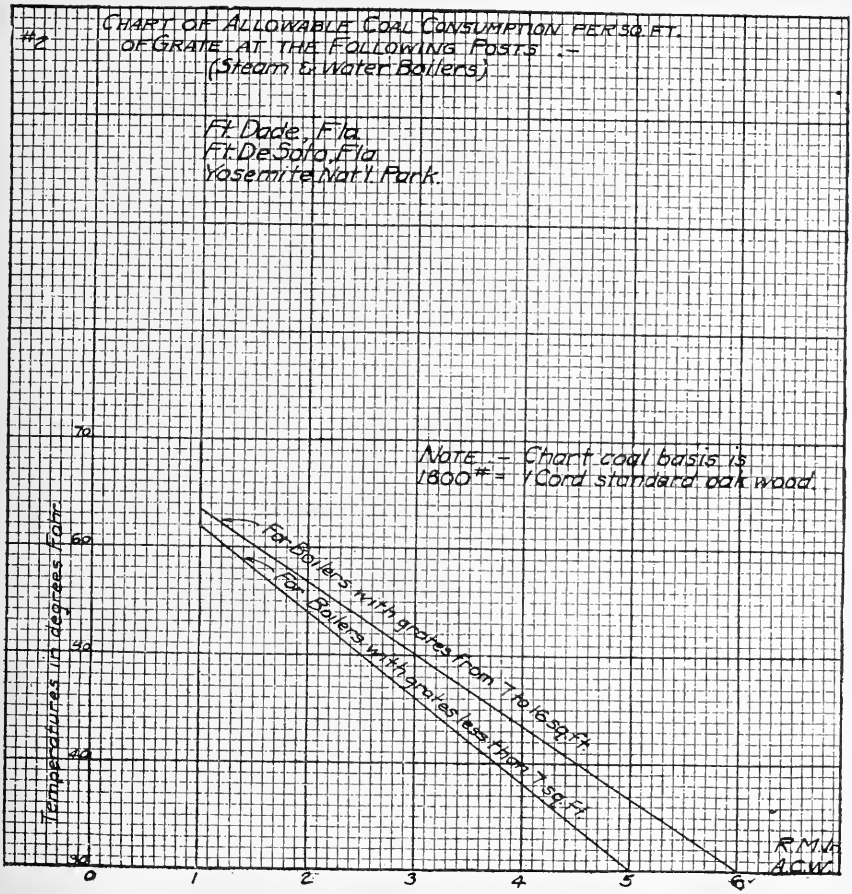
DUNNING.

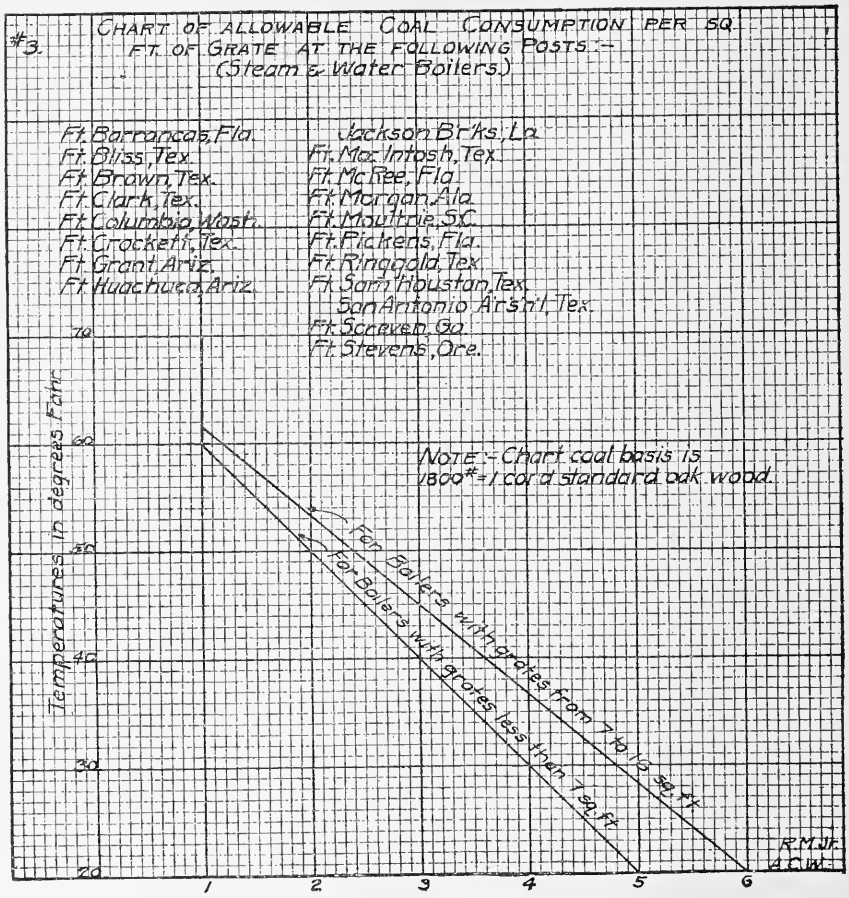
[New York Central Iron Works.]

[This table will also apply to vertical Kewanee steel and small cast-iron boilers.]

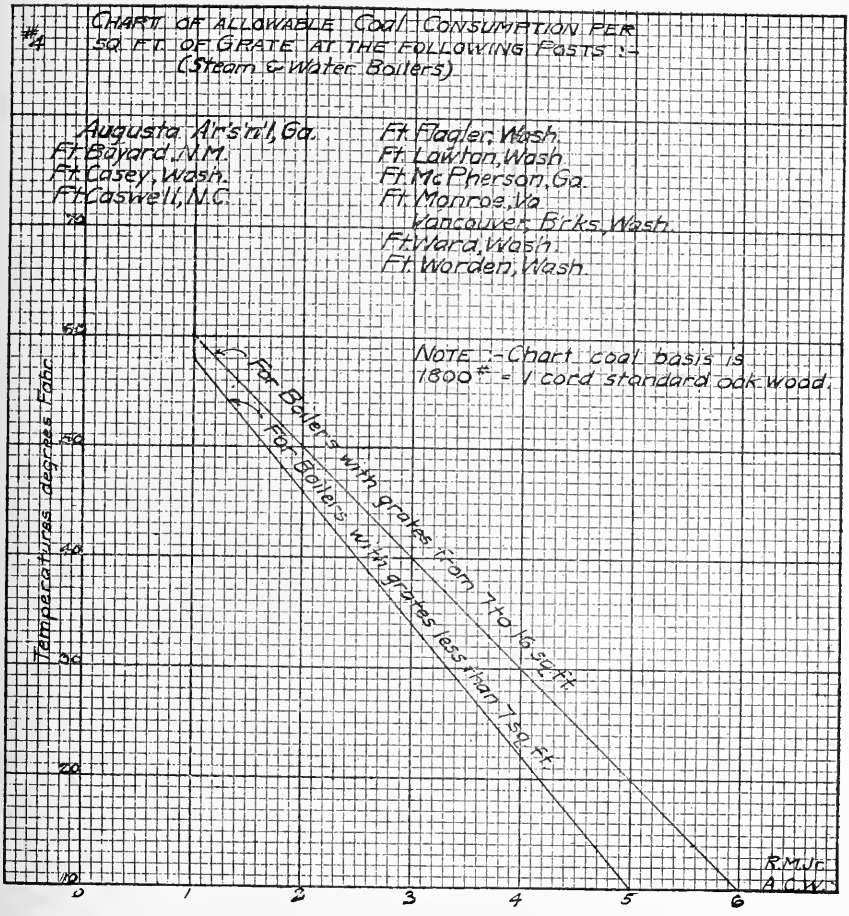
	Capacity in radiation, square feet.		Grate area in square feet.
	Steam.	Water.	
No. 1½	400	650	2.64
No. 2	500	825	3.14
No. 2½	600	1,000	3.69
No. 3	800	1,325	4.27
No. 3½	1,000	1,650	5.25
No. 4	1,200	2,000	6.67
No. 4½	1,400	2,325	7.90
No. 5	1,600	2,650	8.72
No. 5½	2,000	3,300	8.72
No. 5¾	2,500	4,125	10.55
No. 6	3,000	4,950	12.55


#1
CHART OF ALLOWABLE COAL CONSUMPTION PER SQ. F.T. OF GRATE AT THE FOLLOWING POSTS:-
(Steam & Water Boilers)
Alcatraz Prison, Cal.
Ft. Baker, Cal.
Benicia Arsenal, Cal.
Ft. Mason, Cal.
Ft. McDowell, Cal.
Ft. Miley, Cal.
Presidio Monterey, Cal.
Presidio San Francisco, Cal.
Ft. Rosecrans, Cal.
NOTE:- Chart coal basis is 1800# = 1 cord standard oak wood.
For Boilers with grates from 7 to 16 sq. ft.
For Boilers with grates less than 7 sq. ft.
R.M.U.
A.C.W.
Temperatures in degrees Fahr.
70
60
50
40
0
1
2
3
4
5
6
Pounds of coal per sq. ft of grate per hr.
24 hours to constitute a day.

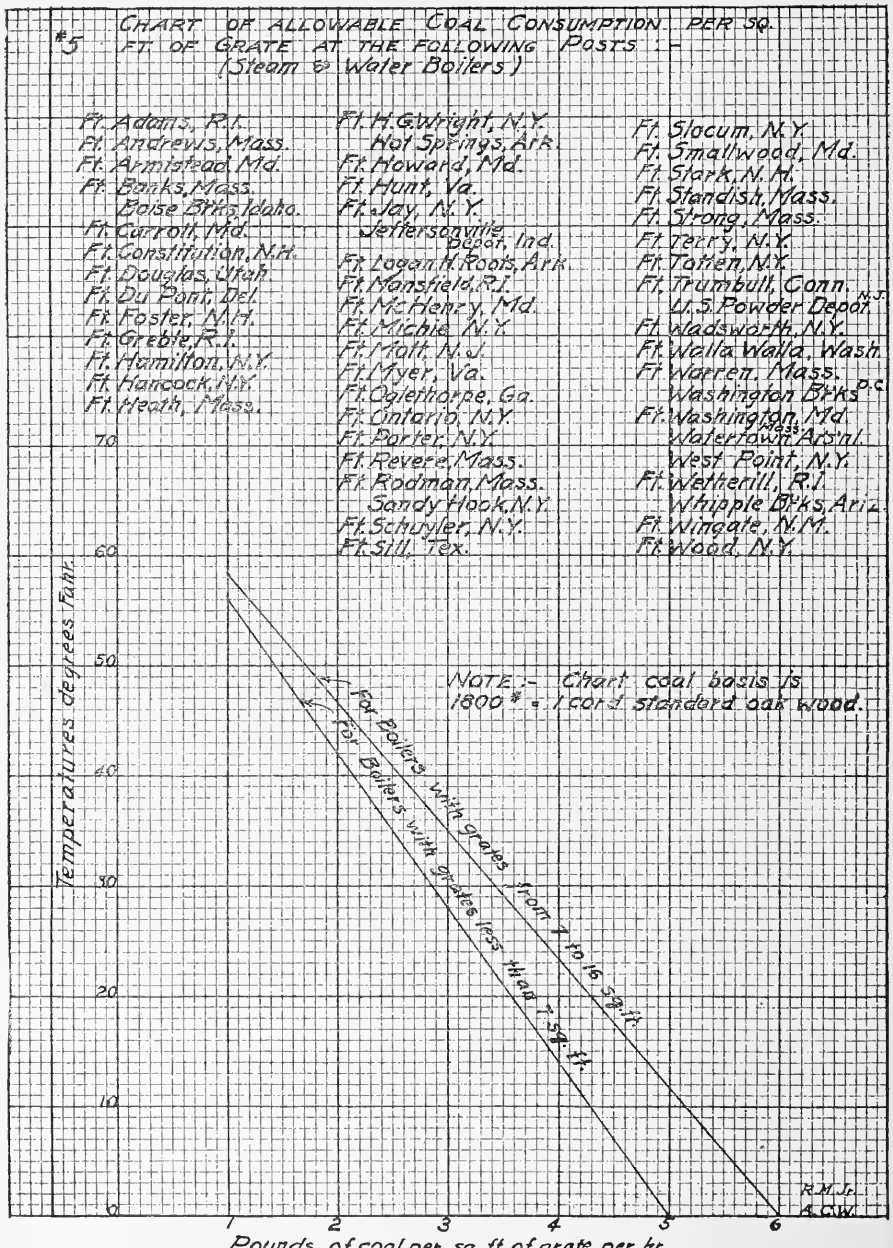

#2
CHART OF ALLOWABLE COAL CONSUMPTION PER SQ. FT. OF GRATE AT THE FOLLOWING POSTS :—
(Steam & Water Boilers.)
Ft. Dade, Fla.
Ft. De Soto, Fla.
Yosemite Nat'l. Park.
NOTE :— Chart coal basis is 1600# = 1 Cord standard oak wood.
For Boilers with grates from 7 to 16 sq. ft.
For Boilers with grates less than 7 sq. ft.
Temperatures in degrees Fahr.
70
60
50
40
30
0
1
2
3
4
5
6
R.M.A.
A.C.W.
Pounds of coal per sq. ft. of grate per hr.
Twenty four hours to constitute a day.

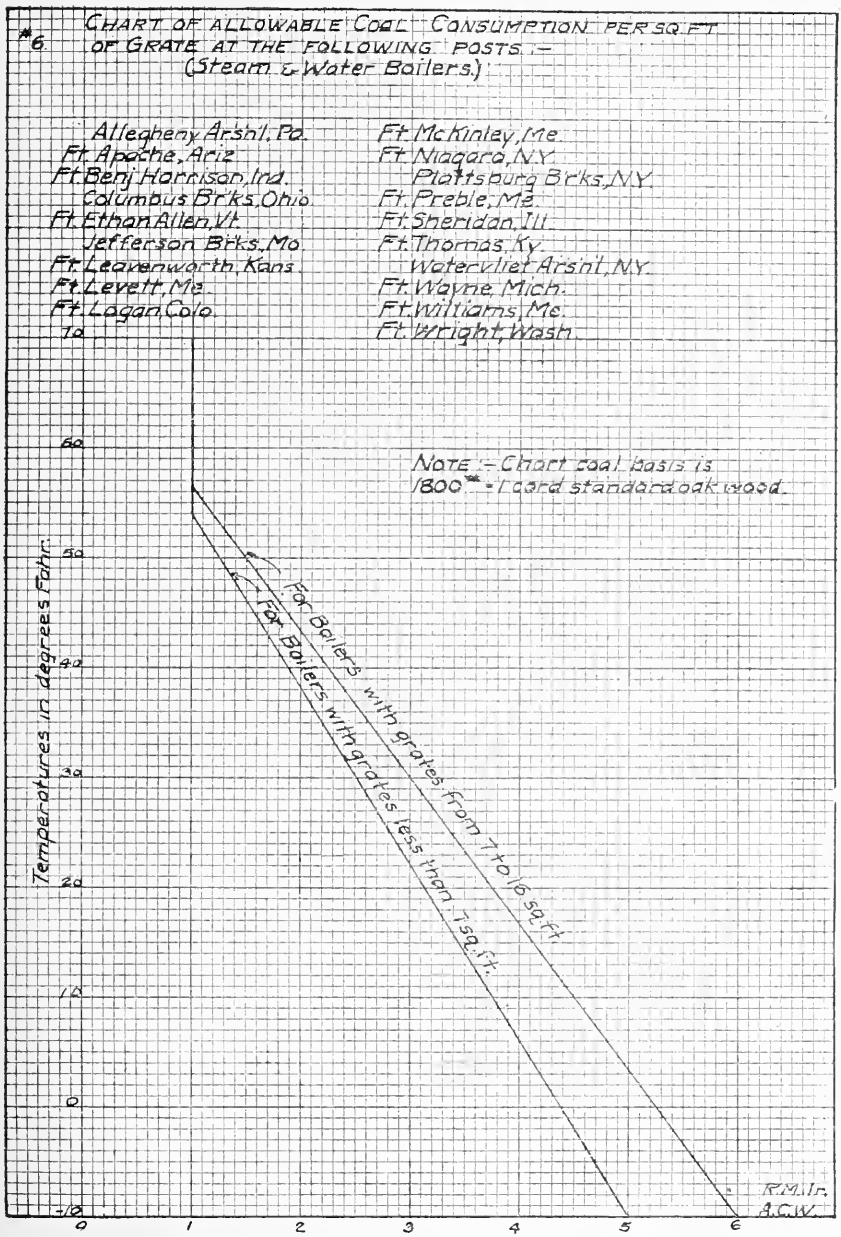


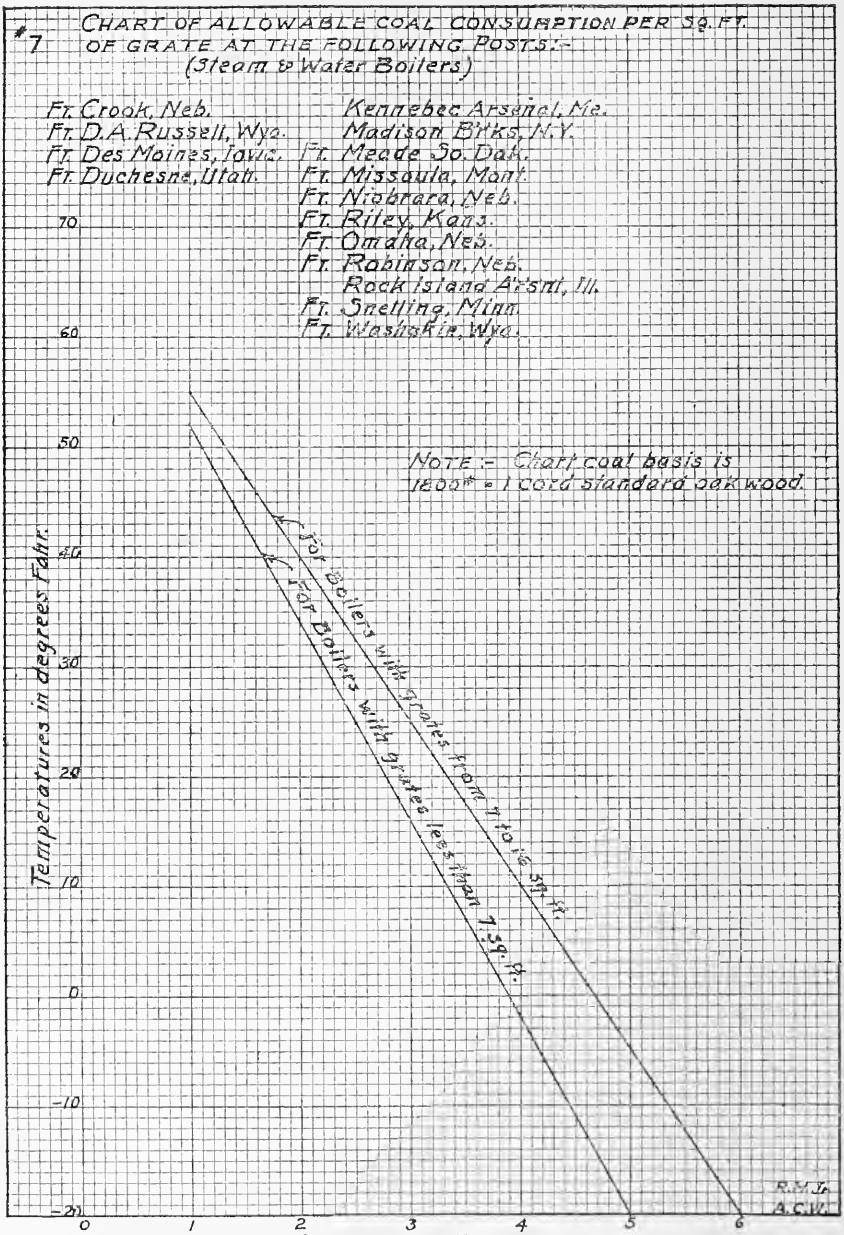
Pounds of coal per sq ft. of grate per hr.
Twenty four hours to constitute a day.

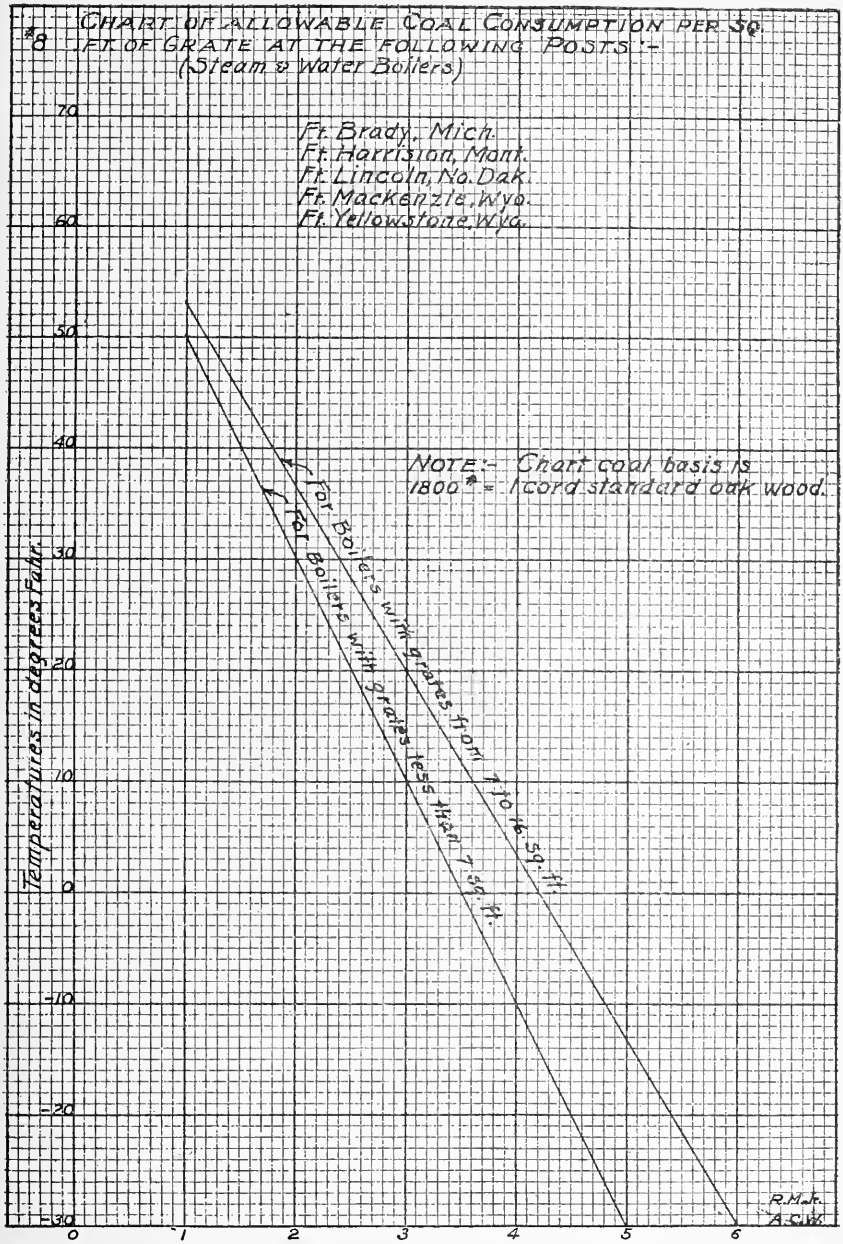


Pounds of Coal per sq.ft. of grate per hr.
Twenty four hours to constitute a day.


#5
CHART OF ALLOWABLE COAL CONSUMPTION PER SQ. FT. OF GRATE AT THE FOLLOWING POSTS :-
(Steam & Water Boilers)
Ft. Adams, R.I.
Ft. Andrews, Mass.
Ft. Armistead, Md.
Ft. Banks, Mass.
Boise Brks, Idaho.
Ft. Carroll, Md.
Ft. Constitution, N.H.
Ft. Douglas, Utah
Ft. Du Pont, Del.
Ft. Foster, M.H.
Ft. Greble, R.I.
Ft. Hamilton, N.Y.
Ft. Hancock, N.Y.
Ft. Heath, Mass.
Ft. H.G. Wright, N.Y.
Hot Springs, Ark.
Ft. Howard, Md.
Ft. Hunt, Va.
Ft. Jay, N.Y.
Jeffersonville Depot, Ind.
Ft. Logan H. Roots, Ark.
Ft. Mansfield, R.I.
Ft. McHenry, Md.
Ft. Michie, N.Y.
Ft. Mott, N.J.
Ft. Myer, Va.
Ft. Oglethorpe, Ga.
Ft. Ontario, N.Y.
Ft. Porter, N.Y.
Ft. Revere, Mass.
Ft. Rodman, Mass.
Sandy Hook, N.Y.
Ft. Schuyler, N.Y.
Ft. Sill, Tex.
Ft. Slocum, N.Y.
Ft. Smallwood, Md.
Ft. Stark, N.H.
Ft. Standish, Mass.
Ft. Strong, Mass.
Ft. Terry, N.Y.
Ft. Totten, N.Y.
Ft. Trumbull, Conn.
U.S. Powder Depot N.J.
Ft. Wadsworth, N.Y.
Ft. Walla Walla, Wash.
Ft. Warren, Mass.
Washington Brks D.C.
Ft. Washington, Md.
Watertown Arsnl. Mass.
West Point, N.Y.
Ft. Wetherill, R.I.
Whipple Brks, Ariz.
Ft. Wingate, N.M.
Ft. Wood, N.Y.
Temperatures degrees Fahr.
70
60
50
40
30
20
10
0
NOTE:- Chart coal basis is 1800 # = 1 cord standard oak wood.
For Boilers with grates from 7 to 16 sq. ft.
For Boilers with grates less than 7 sq. ft.
R.M.J.
A.C.W.
1
2
3
4
5
6
Pounds of coal per sq. ft. of grate per hr.
Twenty four hours to constitute a day.


#6
CHART OF ALLOWABLE COAL CONSUMPTION PER SQ. FT OF GRATE AT THE FOLLOWING POSTS:—
(Steam & Water Boilers.)
Allegheny Arsnl, Pa.
Ft. Apache, Ariz
Ft. Benj Harrison, Ind.
Columbus Brks, Ohio
Ft. Ethan Allen, Vt
Jefferson Brks, Mo
Ft. Leavenworth, Kans
Ft. Levett, Me
Ft. Logan, Colo
Ft. McKinley, Me
Ft. Niagara, N.Y.
Plattsburg Brks, N.Y.
Ft. Preble, Me.
Ft. Sheridan, Ill.
Ft. Thomas, Ky
Watervliet Arsnl, N.Y.
Ft. Wayne, Mich.
Ft. Williams, Me.
Ft. Wright, Wash.
NOTE:—Chart coal basis is 1800 lbs. = 1 cord standard oak wood.
For Boilers with grates from 7 to 16 sq. ft.
For Boilers with grates less than 7 sq. ft.
Temperatures in degrees Fahr.
80
60
50
40
30
20
10
0
-10
0
1
2
3
4
5
6
R.M.H.
A.C.W.
Pounds of coal per sq. ft. of grate per hr
Twenty four hours to constitute a day


#7
CHART OF ALLOWABLE COAL CONSUMPTION PER SQ. FT. OF GRATE AT THE FOLLOWING POSTS:-
(Steam & Water Boilers)
Ft. Crook, Neb.
Ft. D.A. Russell, Wyo.
Ft. Des Moines, Iowa.
Ft. Duchesne, Utah.
Kennebec Arsenal, Me.
Madison Brks, N.Y.
Ft. Meade So. Dak.
Ft. Missoula, Mont.
Ft. Niobrara, Neb.
Ft. Riley, Kans.
Ft. Omaha, Neb.
Ft. Robinson, Neb.
Rock Island Arsnl, Ill.
Ft. Snelling, Minn.
Ft. Washakie, Wyo.
NOTE:- Chart coal basis is 12000# = 1 cord standard oak wood.
Temperatures in degrees Fahr.
70
60
50
40
30
20
10
0
-10
-20
For Boilers with grates from 7 to 14 sq. ft.
For Boilers with grates less than 7 sq. ft.
0
1
2
3
4
5
6
R.M.J.
A.C.W.
Pounds of coal per sq. ft. of grate per hr.
Twenty four hours to constitute a day.



Pounds of coal per sq. ft. of grate per hr.
Twenty four hours to constitute a day.

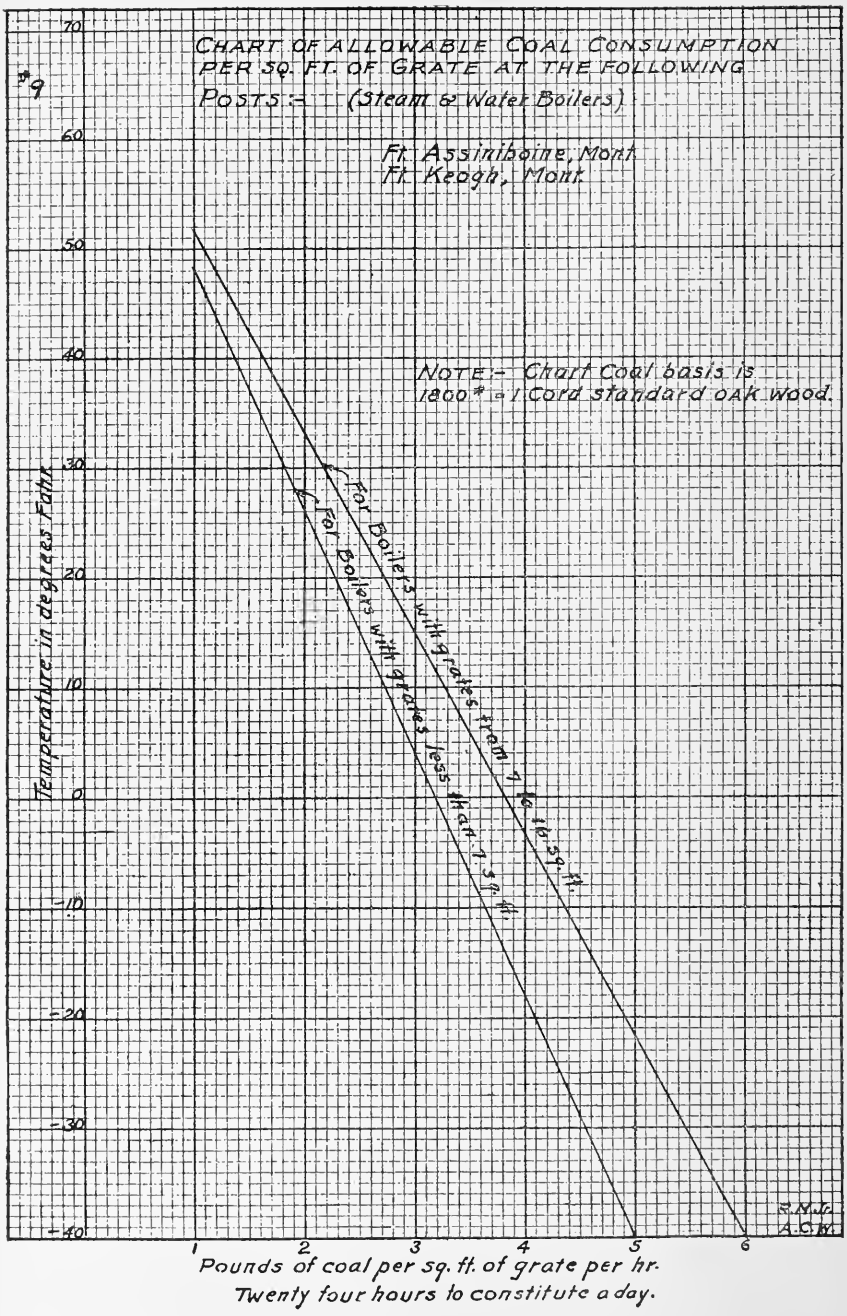


CHART OF ALLOWABLE COAL CONSUMPTION PER SQ. FT. OF GRATE AT THE FOLLOWING POSTS:- (Steam & Water Boilers)
Ft. Assiniboine, Mont.
Ft. Keogh, Mont.
NOTE:- Chart Coal basis is 1200# = 1 Cord standard OAK wood.
For Boilers with grates from 7 to 16 sq. ft.
For Boilers with grates less than 7 sq. ft.
Temperature in degrees Fahr.
70
60
50
40
30
20
10
0
-10
-20
-30
-40
1
2
3
4
5
6
Pounds of coal per sq. ft. of grate per hr.
Twenty four hours to constitute a day.
C.N.J.
A.C.M.

INSTRUCTIONS, FORMS, AND DATA SHEETS ISSUED DURING FUEL TESTS AT FORT MYER, VA., WASHINGTON BARRACKS, D. C., AND FORT SHERIDAN, ILL., FEBRUARY 13 TO MARCH 25, 1914.

Important. Important.

INSTRUCTIONS.

1. HOT-AIR FURNACE SYSTEMS.—The essential features of the hot-air furnace system are: First, a furnace for heating the air; second, a cold-air supply duct or system of ducts for conveying fresh cold air to the furnace; and, third, a system of ducts, risers, and registers for conveying the heated air from the furnace to the rooms to be heated.

2. HOT-AIR FURNACES are either incased in sheet metal or in brick walls. In the former case the furnace is called a portable furnace; in the latter case a brick set furnace. In either case the principle of operation is the same, the steel or brick casing serving to prevent undue radiation of heat from the heated surfaces of the furnace to surrounding objects, and to bring the cold air into close contact with the heated surfaces of the furnace.

3. After the air becomes heated it rises to the upper part of the casing, or of the brick setting, where it enters the various hot-air ducts and is conveyed therein to the different rooms to be heated.

4. The furnace proper is of sheet steel or cast iron and consists of a base containing ash pit, grates on which the fuel is burned, a fire pot to contain the fuel, a combustion chamber above the fire pot to provide ample space for the combustion of the gaseous portions of the fuel, and a radiator through which the hot smoke and gases must pass before they are allowed to pass out through the smoke pipe to the chimney.

5. The circulation of air through the ducts and risers of a hot-air furnace system is due to the fact that after the air has passed over the furnace and becomes heated it expands and becomes lighter than the same volume of cold air. Thus the comparatively heavy cold air enters the furnace by way of the cold-air inlet, forcing the lighter and hotter air upward through the heated space between the furnace and the casing and into the hot-air ducts leading to the different rooms.

RULES FOR OPERATING FURNACES.

6. In severe weather keep the fire pot *fairly well filled* with coal and have it evenly distributed over the grate. The fire will need attention oftener in severe weather than in mild weather, however, and no attempt should be made to avoid this by heaping an undue amount of coal into the furnace at one firing. If the fire is too deep, it is likely to be extremely wasteful.

7. In milder weather a somewhat lighter fire should be carried, and combustion should be checked by partially closing damper in smoke pipe and by partially opening fire door if necessary. Do not allow fire pot to fill up with ashes in mild weather, but reduce the fire by regulating the draft.

8. Always keep the fire clean. Clinkers should be removed from fire once or twice daily as necessary. It is not necessary to stir the fire so completely as to waste coal through the grate.

9. When replenishing a poor fire, do not shake the fire, but put some coal on and open the drafts. After the fresh coal is well ignited, clean the fire.

10. *The ash pit must be frequently cleaned. An accumulation of ashes below the grate soon warps the grate and burns it out.*

11. If furnace is provided with water pans, keep them full of water.

12. Clean the furnace and smoke pipe thoroughly in all parts at least twice a year.

13. Keep the fresh-air duct clean and free from rubbish.

14. Allow plenty of pure, fresh air to enter the furnace at all times except in extreme cold weather, when the fresh-air supply may be cut down to some extent.

15. To bank the fires for the night, clean the fire, push the coals near the rear of the grate, cover with fresh fuel to the necessary depth (this will be found by experience), set the drafts so that they are all nearly closed and partially open the fire door.

16. LOW-PRESSURE STEAM-HEATING SYSTEMS.—The essential features of the low-pressure gravity return steam heating system are: First, a boiler for heating water and evaporating it into steam; second, a system of piping for conveying the steam to and the water of condensation from the radiators; and, third, radiators which are placed in the rooms to be heated and in which steam is condensed, thereby giving off heat.

17. There are many makes and styles of steam heating boilers, most of which may be classed with one of the two general types following: First, portable steel boilers; and, second, cast-iron sectional boilers. While these two types are of entirely different construction, the essential features of each are much the same. Each contains a water space through which the water passes while being heated, and in which the water is brought into contact with those portions of the boiler which receive heat from the fire or from the hot gases arising therefrom. Directly above the water is the steam space, into which steam passes as it is evaporated and before it passes to the main steam pipes.

18. In connection with every steam boiler is a *furnace* with ash pit, grates, fire pot, combustion chamber, and in which the fuel is burned. In all cast-iron heating boilers and in portable steel boilers of such type as the Dunning elongate or the Kewanee portable the fire pot and combustion chamber are contained in the boiler itself. In certain types of portable steel boilers, such as the Century or Ideal, the fire pot and combustion chamber are outside of the boiler proper and are connected with it by a brick-lined metal casing.

19. The circulation of steam in the pipes and radiators of a low-pressure gravity return steam-heating system is due to the fact that as steam condenses in the radiators the pressure is slightly lowered, thus inducing the flow of more steam from the boiler to take its place. The condensed steam or water of condensation, being many times heavier than the steam, is drained back by gravity through suitable pipes to the boiler, where it is again heated and evaporated and again passed into the piping system as steam.

20. In the foregoing paragraph the circulation of steam has been explained, assuming that the whole system—steam space of boiler, steam pipes, and radiators—is filled with steam at the start, and this is the action which does take place when the whole system has once become hot.

21. *In starting up a cold system*, however, *an entirely different condition is met with and it is important that this be thoroughly understood.* In starting up a cold system the whole of the system above the water line of the boiler is filled with air and until this air can be gotten rid of the steam can not circulate and the radiators can not be heated. For the purpose of venting this air, valves are place on all radiators and on long runs of steam pipes. These are called "air valves" and are of such construction that they will allow air to pass through them freely but will close against the passage of steam or water. Many types of air valves are in general use, but to be successful in operation they must all meet the above requirements.

22. From the above it is evident that the *proper operation of air valves is of great importance.* And in the case of failure to heat a room properly the trouble is often due to faulty operation of the air valves on radiators in that room, and in a case of this

kind the radiators in the room in question should be examined to see that they are *steam hot all over.* In case they are not and there is pressure in the system the *fault is almost invariably with the air valves.* Some air valves permit of adjustment by removing a cap at the top of the air valve and slightly opening or closing valve by means of a key or screw driver. The following rules should be observed in *making any adjustment to air valves. Never attempt to adjust them except when there is at least one pound steam pressure on the system.* Then if radiator does not heat properly *remove cap from air valve and slack off screw or nut at top of valve until air blows through freely.* Allow this action to continue until radiator is hot throughout and steam appears at air valve. *Then tighten valve just enough to stop all leakage of steam and replace cap. Do not remove air valve from radiator. If valve leaks steam or water, tighten just enough to stop leak.*

RULES FOR OPERATING STEAM HEATING BOILERS.

23. Steam heating boilers should receive attention at least three times a day, and in severe weather will require attention more frequently.

24. In the morning, fires should be cleaned, a fresh supply of coal put on fire and drafts adjusted. (See par. 33.) In the afternoon it will generally be necessary to supply more fuel and shake down the fire, care being taken not to let live or unburned coal pass through the grate. At night the fire must be cleaned and banked (see par. 15) and drafts closed.

25. The proper thickness of fire will in general vary from 4 inches to a foot. It varies according to the kind of coal used and the draft available, and must be determined by experience for any particular case. Fire must not be so thick as to obstruct the draft or to allow gases to pass off unburned, and must not be so thin as to allow cold air to leak through. (See also pars. 6, 7, 8, 9, 10, and 15, under "Rules for operating hot-air furnaces.")

26. Before firing up in the morning *examine the water gauge and test the try cocks to see that there is sufficient water in the boiler.* Water should show just above the middle point of gauge glass or just above middle try cock if three cocks are installed on water column. When cocks are opened, upper cock should blow steam; middle cock steam and water; and the lower cock should blow water only. When try cocks are tested, be sure to close them tightly. See if the *pressure gauge stands at zero.* Slightly open *safety valve* by hand *at least once a week to see that it does not become stuck.*

27. All steam boilers should be provided with a fusible plug which will melt in case of low water in boiler, blowing steam, and thus giving warning of low water and sometimes preventing further damage to the system. If gauge glass and try cocks show low water in the boiler, however, do not wait for plug to blow and do not assume that because it has not blown it will be safe to feed water to boiler, but follow instructions given in paragraph 31 at once. If plug does blow out, replace it with another fusible plug and in no circumstances with a solid plug.

28. In starting a fire under a cold boiler *do not force it, but allow boiler to warm up gradually. Failure to observe this rule may result in serious injury to boiler.*

29. Hard coal may be thrown evenly over the fire. Soft coal should at first be banked in front on the grate, until the gases are driven off. It should then be pushed back over the fire.

30. Keep *boiler tubes and flues and smoke pipe clean and free from soot.* Boilers burning soft coal should be *cleaned at least once a week.*

31. In case of *low water* in a steam boiler *cover the fire with wet ashes or coal and close all drafts and open fire or fuel door. Do not open the safety valve. Do not feed water to the boiler. Do not draw the fire.* Keep the conditions such as to *avoid any sudden shock.* After the steam pressure has dropped, draw the fire. *Do not feed water to the boiler until it is fairly cool.*

32. When heating system is shut down in the spring *draw all water from system and make necessary repairs. Fill* boiler with fresh water till it appears at safety valve and

leave it full through the summer. In the fall draw all water out of boiler, fill with fresh water to level of water line and fire up gradually.

33. See that *damper regulator* is *working properly* and that *chains connecting draft door* in ash pit and draft check in smoke pipe are properly connected to damper regulator. With the steam gauge showing 2 pounds pressure on the boiler both the draft door and draft check should be closed and connecting chains should be taut. Then if pressure rises the draft check will be opened, admitting cold air to the smoke pipe and thereby checking the fire; or if pressure drops, the draft door will be opened, admitting more air to the ash pit and thereby increasing the combustion. After chains are properly adjusted, do not disconnect them, but make necessary adjustments by moving weight on lever. Thus at night when fires are banked and it is not desired to carry any pressure on boiler move weight to such a point as will prevent draft door in ash pit from opening when pressure drops to zero. A mark should be placed on lever arm to indicate proper position of weight to maintain a pressure of 2 pounds, so that it may be readily adjusted when firing up in the morning.

34. The essential features of the low-temperature *gravity return hot-water heating system* are: First, a boiler for heating water; second, a system of piping for conveying the hot water to the radiators and the cooled water back to the boiler; third, radiators, which are placed in the rooms to be heated and in which water is cooled, giving off its heat to the room; and fourth, an expansion tank, which is a tank open to the atmosphere and located above the highest radiator or the highest run of piping in the system. The expansion tank is connected to the piping system and serves as a reservoir to take up the expansion of the water when it becomes heated, and also to vent air from the system and to safeguard the system from damage due to overheating the water in the boiler.

35. Hot-water heating boilers are of the same types as steam-heating boilers, and for all practical purposes may be considered the same. Some of the boiler fixtures are different, however. No water column or water gauge is necessary on a hot-water boiler, since the boiler is filled with water, and in place of a pressure gauge such as is used on a steam boiler, an altitude gauge which indicates the height of water in the system is used in connection with a hot-water boiler. Ordinarily a hot-water system is laid out with no valves on any piping between the boiler and the expansion tank, and in such cases no safety valve is required on boiler. It is usual to place two thermometers on the main piping near a hot-water boiler, one to show the temperature of water in the supply piping and the other to show the temperature of water in the return piping, after it has become cooled by passing through the radiators.

36. The circulation of water through the pipes and radiators of a hot-water heating system is due to the fact that as the water is heated in the boiler it expands slightly, thus becoming lighter than an equal volume of cooler water, The cooler and heavier water coming into the boiler through the return connections forces the lighter and hotter water upward through the supply piping to the various radiators. In the radiators the water is slightly cooled and so passes out through the return piping and back to the boiler. Since in most cases the water passing through the radiators is cooled very slightly, sometimes not more than 10° F. or 15° F., the force causing the water to circulate is very small. In a properly designed system it is, however, sufficient to give a good circulation.

37. In a hot-water system, as in a steam system, it is necessary that the piping and radiators shall be thoroughly vented of air before proper circulation can take place. In a hot-water system, however, most of the air is vented through the expansion tank when the system is filled. The air in the radiators is vented by opening the small hand operated pet cocks at the top of radiator and letting the air blow until water appears, when cock should be tightly closed. After system is filled with water and freed from air, it is necessary to see that air does not collect in system, and all pet cocks on radiators should be tested occasionally, and altitude gauge should be examined every day to see that the water in the system is at the proper height.

RULES FOR OPERATING HOT-WATER HEATING BOILERS.

38. For general instructions in regard to care of boiler, method of firing, etc., see paragraphs 6, 7, 8, 9, 10, and 15, under "Rules for operating hot-air furnaces," and paragraphs 23, 24, 25, 28, 29, 30, and 32, under "Rules for operating steam-heating boilers."

39. Before firing up in the morning examine the altitude gauge to see if the system is full of water. Most altitude gauges have a stationary hand which should be set at the point on the dial at which the movable hand registers when system is full of water. After being set at this point, this hand will always indicate the height of water which should be maintained in system. If there is any doubt as to the system being full of water, inspect the water level in the expansion tank or feed water to the boiler until it overflows from expansion tank.

40. Before firing up be sure that all valves on the main supply and return piping are open.

41. The damper regulator on a hot-water boiler operates in the same manner as that on a steam boiler except that instead of being adjusted to maintain a certain pressure on the boiler, it must be set to maintain a certain temperature of water leaving the boiler. This temperature will depend on outdoor temperatures, and for severe weather conditions will be about 180° F. in most cases. Thus if a comfortable temperature can be maintained indoors with water leaving the boiler at 180° F. in severe weather, the weight on lever arm of damper regulator should be placed so that both the draft door in ash pit and the check draft in smoke pipe will be closed and the chain connecting with each door will be tight when water leaving the boiler is at the above temperature.

Post .....

Building No. ..... Designation .....

Month of ..... 191—.

Day.	Temperature record.						Record of coal used.	
	Dormitory (barracks), living room, (quarters).			Day room (barracks).			For heat.	For cooking.
	7 a. m.	11 a. m.	7 p. m.	7 a. m.	11 a. m.	7 p. m.	Can filled.	Can filled.
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
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13								
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30								
31								

Temperature record is to be filled in for each day of the month and at the hours shown on form.

Under "Record of coal used," the time at which it is necessary to fill can with a fresh supply of coal is to be recorded opposite proper date. After can is filled, coal may be shoveled from can or may be dumped on basement floor and shoveled from there. Each can full must be all used before can is filled again. Thus the first entry under "Can filled" would be, say, "7.30 a. m." and would be opposite the first day of the month; the next might be "5 p. m." and might be opposite the 6th day of the month. In this way each can full is to be recorded, and in space opposite the last day of the month the amount left over from the last can full recorded should be noted, as "$\frac{1}{4}$ can full," "$\frac{1}{2}$ can full," etc. This quantity is to be carefully estimated with *coal in can*.

Cans to be filled *level with top*.

Coal for cooking must be kept in a separate can, and when refilled it must be recorded in proper column.

Readings to be taken each day at 7 a. m., 11 a. m., and 7 p. m. and entered separately on form. The first reading will show how much the building has cooled off during the night; the second how well the heating plant is responding to the morning overload; and the third will show whether a satisfactory temperature is being maintained at the time when it is probably of most importance.

Post ....

Temperature record. *Month*....., *191*...

Monthly mean .....

Day.	Maximum.	Minimum.	Daily mean.
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
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28			
29			
30			
31			

$$\text{Daily mean} = \frac{\text{maximum} + \text{mimimum.}}{2}$$

$$\text{Monthly mean} = \frac{\text{Sum of daily means.}}{\text{Number days in month.}}$$

Heating data sheet for ....

Building.		Boiler manufacturer's name and trade name.	Manufacturer's No.	Capacity.	Grate for hard or soft coal.	Steam, hot water, or air.	Date of installation.	Square feet of direct radiation surface in building.	Square feet of direct indirect radiation surface in building.	One or two pipe system.	Amount and kind of coal burned during period from Feb. 1 to Feb. 28, both inclusive.
Designation.	Post No.										
....	....	....	....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....	....	....	....
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....	....	....	....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....	....	....	....

OFFICE CHIEF OF QUARTERMASTER CORPS,
Washington, D. C., April 13, 1914.

From: P. M. Anderson, electrical and mechanical engineer.

To: Chief, Quartermaster Corps, United States Army, Washington, D. C.

Subject: Fuel tests.

1. In accordance with your orders dated January 28, 1914, directing that I conduct fuel tests during the months of February and March at Fort Myer and Washington Barracks, I have the following report to submit. These orders were verbally supplemented to include fuel tests in several apartment houses in this city also. This report covers observations made at the Wyoming, Highlands, Westmoreland, and Belmont apartment houses and the Army and Navy Club.

2. After making preliminary inspections at Fort Myer and Washington Barracks, it was considered advisable to divide the work, Mr. L. H. Tripp, sanitary and heating engineer, taking personal charge of the work at the former post, and I took charge of the work at Washington Barracks and the apartments. A separate report on Fort Myer will be submitted by Mr. Tripp.

3. On preliminary inspection at both posts it was found that approximately 85 per cent of the heating boilers were regulated by means of the firing door; the automatic regulators were either out of working order or had been disconnected. The flues and heating surfaces of practically all boilers were heavily coated with soot, and in a few cases conditions indicated that the soot had not been removed in years. In one heating boiler an accumulation of soot had completely closed off the lower row of tubes and the second row was closed off to within one-third of its area. With a very few exceptions, the heating systems showed lack of care and lack of proper supervision.

4. The test was started at Washington Barracks February 13, after all boilers had been thoroughly cleaned and damper regulators properly adjusted. A daily record was made on the amount of coal used for heating and cooking, and temperatures were taken in all heated buildings at 7 a. m., 11 a. m., and 7 p. m. In officers' and noncommissioned officers' quarters the thermometers were installed in the living rooms, and in barracks the records were taken both in dormitories, day rooms, and mess halls. The first temperature reading was taken early enough in the day to indicate the condition of the fires throughout the night, the second temperature reading was taken at a time when the morning chill should have been removed if

the fire was in good condition in the morning, and the last reading was taken at a time which would show the average afternoon and evening temperature.

5. All heating boilers were fired by the regular firemen, who were as a rule privates from the companies and who received no extra pay for this extra duty. Three first-class engineer sergeants, Quartermaster Corps, were detailed to the post to supervise the firing and to keep an accurate daily check of the inside temperatures and the daily consumption of fuel, both for heating, cooking, and laundry purposes. The post was divided into three parts and each engineer sergeant was detailed to supervise one division throughout the test. In this way, each became very familiar with the equipment and the firemen in his division, and were therefore able to keep very accurate records. A separate record was kept of the coal used in laundry stoves of officers' quarters, but in all tabulations herewith the fuel used in laundry stoves has been included with fuel for cooking. It was found that the laundry work, especially the ironing, was being done in the kitchens, and the separated values would therefore be misleading.

6. Inclosed herewith is a blue-print tabulation showing the results of tests on all buildings at this post. It will be noted that there are only two types and sizes of officers' quarters and that the same type of cast-iron boilers is installed in all. Inclosed herewith are blue-print graphical records of the operation of each separate boiler and an average graphical record for each of the two sizes of boilers. These graphs show the average daily inside temperatures, which were obtained by averaging the three daily temperature readings. One curve shows the daily mean outside temperatures, which were obtained from the average of 24 hourly readings as recorded by the United States Weather Bureau. A third curve shows the proposed allowance, according to chart, for each day based on the size of the grate and the mean temperature of that day. A fourth curve shows the amount of coal actually consumed each day for heating. In plotting these records, it was found that the coal consumption did not in all cases follow the allowance based on temperatures. It was believed that wind movements were largely responsible for this discrepancy. A fifth curve was therefore plotted showing the total number of miles of wind movement each day and the direction of same.

7. These charts show that in many instances where the coal consumption has increased or decreased out of proportion to temperature change, the cause can be traced back to high or low wind movement. It is apparent also, from examination of these charts, that the personal element must be taken into consideration. The depth of fire, the draft control, and the method of cleaning fires, all tend to influence the daily fuel consumption. It was found that the greatest wastage in fuel existed in the mildest weather, for the reason

that on mild days the firing was not reduced proportionally and windows were opened to reduce the excessive inside temperatures. It was found that in practically all cases excessive heat was disposed of through open windows rather than by turning off radiators. All rooms and buildings should be heated sufficiently to permit of proper ventilation, but it seems unnecessary to leave steam turned on the radiators in sleeping rooms where windows are left open throughout the night.

8. It is believed that the coal consumption during this test was materially less than it would have been if the fires and heating equipment had been cared for in the usual way. It is certain that some fuel was saved by keeping the equipment free from soot. Another great saving was undoubtedly made by properly regulating the drafts. I found on a visit to this post a few days after the test was closed that about 50 per cent of the automatic regulators had either been disconnected or were blocked to prevent their operation. The firemen had returned to their former method of regulating and checking the fires by opening the firing doors of the furnaces. Certainly this is an effective method of checking a fire but a very inefficient method. Practically all furnaces are provided with some form of flues for the absorption of heat from the hot gases after leaving the combustion chamber. When the firing door of a furnace is opened as a check against excessive heat it does check combustion to a large extent, but it permits cold air to chill the heating surface and waste a great deal of heat, which could be avoided by proper control.

9. The proposed allowances based on the charts prepared by this office seem to provide a fair allowance for the officers' quarters having 5.03 square feet of grate. The allowance for officers' quarters having 7.16 square feet of grate is excessive. This chart was prepared for Dunning boilers, which have a higher rating per square foot of grate than do the Gurney boilers installed at this post. The equipment at this post is not representative of the average conditions at Army posts, and I, therefore, do not recommend that this allowance be reduced on the basis of this test. It is believed that the allowance charts as worked out represent very closely the actual annual consumption of the average boiler at heating plants of Army posts in this vicinity. If the allowances are computed on mean temperatures for each month separately, it is believed that they will be excessive during the coldest months of the season and insufficient for the milder months. To substantiate this conclusion, two charts are inclosed herewith which show a comparison of the proposed chart allowances and the average actual consumption of each of the two sizes of furnaces installed. It will be noted that the line drawn to represent the average of these points gives a greater allowance in mild weather and a smaller allowance in cold weather.

Theoretically the proposed chart allowance is correct, but, as pointed out in another part of this report, there is a greater wastage of fuel in mild weather than during the more severe conditions. The fact that this proposed allowance is excessive on the large grates at this post is due largely to the fact that this grate falls within the allowances on large heating boilers for public buildings. It is therefore recommended that the allowance for officers' quarters be based on the proposed allowances for small grates. It is also recommended that due consideration be given to changing the proposed allowance charts so as to slightly reduce the allowances for officers' quarters in severe weather and give a proportional increase in mild weather.

10. The barracks and a few additional buildings at this post are heated from two central plants which are operated in parallel. One of these plants furnishes approximately 15-boiler horsepower for operating an air compressor for sewage ejector. These plants also furnish hot water to a portion of the buildings heated. It is therefore difficult to check the proposed chart allowances with the actual fuel consumption in these buildings. The water heaters installed are not of the usual type, and the number in use is not sufficient to establish any allowances for this purpose. The heating and hot-water-heating equipment at Fort Myer is typical of the installations at Army posts and can better be used as a basis for establishing allowances.

11. The proposed chart allowances do not provide an allowance for heating with stoves or latrobes such as are installed in noncommissioned officers' quarters at this post. The results of tests at this post would indicate that an allowance of 75 pounds per day for the entire heating season should be allowed a set of noncommissioned officers' quarters heated by stoves in this locality; proportional changes being made for different climatic conditions.

12. The proposed allowance charts cover fuel for heating only. It will therefore be necessary to provide allowances for cooking, laundry purposes, and for heating hot water. No separate allowance for hot water heating will be necessary for officers' quarters, as the hot water is heated from ranges. It is believed that cooking and laundry allowances in officers' quarters should be combined, as in many cases a large portion of the laundry work is done on kitchen ranges. It is therefore recommended that additional allowances be established for cooking and for heating hot water in barracks.

13. The results of the tests at this post indicate that for No. 5 ranges in officers' quarters an allowance of 140 pounds per day should be made and that an allowance of 90 pounds per day should be made for No. 3 ranges in officers' quarters. These allowances should be the same throughout the year. It is recommended that an allowance of 75 pounds per day be made for cooking in non-

commissioned officers' quarters during heating season, and 50 pounds per day for the remainder of the year. Two distinct allowances are recommended for noncommissioned officers' quarters, for the reason that these ranges are also used for heating a portion of the building.

14. The allowance for other sizes of ranges can not be accurately arrived at from the data collected at this post. The coal consumption of the large ranges depends largely on where same are installed. For that reason, the fuel allowance for cooking on the larger ranges should be for the organization rather than for the range. From results of test at this post, it would appear that 3 pounds of coal per man per day would be a fair allowance. No allowance for heating hot water can be arrived at from the equipment at this post.

COST OF HEATING APARTMENT HOUSES.

15. An accurate check was made on the cost of heating and heating hot water in four apartment houses in this city, namely, the Wyoming, Highlands, Westmoreland, and the Belmont. It is believed that these apartment houses represent the average conditions to be expected in this class of buildings. The results of these tests are shown on tabulation herewith.

16. The Wyoming is fitted with a gravity return heating system, and is heated by two 90-horsepower return tubular boilers using bituminous run-of-mine coal at $3.80 per ton. Hot water for the building is provided by two separate internally fired heaters using the same type of coal. The costs of heating and heating hot water in this building as tabulated are determined from total annual costs. Separate tests were made at different temperatures, which show that the fuel consumption of a large apartment is proportionally higher in mild weather than during severe weather.

17. The Highlands and Westmoreland are equipped with a Webster vacuum heating system and are both heated by exhaust steam from a power plant installed in the Highlands. In order to determine the cost of heating these buildings, it was first necessary to determine the evaporation per pound of coal so as to evaluate the steam. This was done by weighing the coal used in actual operation for four consecutive days and weighing the feed water for that period. A water weigher was then installed in the returns from each building separately, and records taken for several days at various outside temperatures. When the outside temperature drops below 24° F. for an appreciable time, it becomes necessary to use live steam in addition to the available exhaust steam. Since live steam must be used at times, the power generated must be considered the by-product and the full charge against heat loss must be made against heating. It was found that 84.5 per cent of the latent heat of steam was expended in heating. A charge of 84.5 per cent of the cost of generating the

steam measured from the returns was therefore charged against the heating system. If no live steam had been required for heating, the heating should properly have been considered a by-product and only such charge made as would represent the loss in efficiency of the engines due to operation on 1.6 pounds back pressure as compared with free exhaust. At this plant this loss would be about 10 per cent. The boiler efficiency of this plant is very high and does much to reduce the cost of heating.

18. The fuel cost of this plant is kept at a minimum. The plant is fitted with two 250-horsepower water-tube boilers and four automatic underfeed stokers. The coal used is composed of approximately one-fourth anthracite screenings and three-fourths bituminous slack. This mixture is obtained at $3.29 per ton and is burned practically without smoke.

19. Hot water for these two apartments is heated by separate automatically controlled live steam closed heaters. The condensation from these heaters was weighed for several days, and the value of such live steam charged in full against heating hot water. It will be noted that this charge is very high as compared with the cost of hot water per room in the Wyoming. This is due to the fact that a higher and more uniform temperature is maintained than to less efficient equipment.

20. The Belmont is equipped with a gravity return heating system and heated by cast-iron low-pressure boiler using bituminous run-of-mine coal. Hot water for the building is heated by an internally fired cast-iron heater using the same fuel. The cost of heating and heating hot water as tabulated is based on total annual costs.

21. The tabulation herewith shows the cost of heating in the Army and Navy Club. These computations are based on data submitted by the manager of this building. It will be noted that the space chargeable to living rooms is a small portion of the building. The high cost per room for heating in this building can not therefore be readily compared with costs in apartment houses.

22. The results of tests in these apartments indicate that the cost of heating is practically the same for all similar buildings, regardless of size. The tests also show that the fuel consumption is proportionally higher in mild weather than during more severe weather conditions. Similar conclusions were reached at Washington Barracks. It is therefore believed that the proposed allowance charts as prepared in this office should be changed slightly for officers' quarters so as to reduce the allowance in severe weather and provide a proportional increase in mild weather.

P. M. Anderson,
Electrical and Mechanical Engineer.

(Twenty inclosures.)

	Name of apartment and how heated.				
	Wyoming (live steam).	Highlands (exhaust steam).	Westmoreland (exhaust steam).	Army and Navy Club (live steam.)	Belmont (live steam).
Number of cubic feet heated space	1,403,968	849,882	650,664	960,000	160,500
Cubic feet of public heated space not chargeable against rooms	None.	84,000	16,522	810,000	None.
Cubic feet of heated space chargeable to rooms	1,403,968	765,882	634,142	150,000	160,500
Number of rooms	388	302	226	69	48
Number of apartments	88	72	54	None.	8
Average size of room, cubic feet	3,618	2,535	2,805	2,175	3,345
Total annual cost of coal for heating and heating hot water	$2,500.00	$2,400.00	$1,515.00	$1,193.00	$261.00
Total annual cost of coal for heating hot water only	276.00	568.00	324.00	(1)	(1)
Annual labor and repair charge for heating and heating hot water	900.00	600.00	400.00	1,275.00	100.00
Approximate cost of heating system	20,000.00	11,000.00	8,000.00	18,428.00	2,500.00
3 per cent depreciation	600.00	330.00	240.00	553.00	75.00
Total cost for heating and heating hot water	4,000.00	3,330.00	2,155.00	(1)	436.00
Total cost for heating and heating hot water chargeable to rooms only	4,000.00	3,000.00	2,100.00	3,021.00	436.00
Total cost per room for heating only	9.61	8.06	7.87	14.14	(1)
Total cost per room for heating and heating hot water	10.32	9.94	9.30	(1)	9.09
Total cost per room for heating hot water only	.71	1.88	1.43	(1)	(1)

(1) Not determined.

OFFICE CHIEF OF QUARTERMASTER CORPS,
Washington, D. C., April 15, 1914.

From: L. H. Tripp, sanitary and heating engineer.

To: Chief, Quartermaster Corps, United States Army, Washington, D. C.

Subject: Fuel tests.

1. In accordance with your orders dated January 28, 1914, directing that I conduct fuel tests during the months of February and March at Fort Myer and Washington Barracks, I have the honor to submit the following report. These orders were verbally supplemented to include investigation of the cost of heating at the Army and Navy Club. The results of the latter have been incorporated in report of Mr. P. M. Anderson, electrical and mechanical engineer, of this office, in connection with tests conducted by him to ascertain the cost of heating in apartment houses.

2. After making preliminary inspections at Fort Myer and Washington Barracks it was decided to divide the work, Mr. P. M. Anderson taking charge of the work at Washington Barracks, while I took charge of the work at Fort Myer. A separate report on Washington Barracks has been submitted by Mr. Anderson.

3. On February 3, 1914, the writer first visited Fort Myer in connection with the fuel tests which have just been completed. The proposed test was discussed with the post quartermaster, and it was decided to proceed at once with an inspection of all of the heating plants at the post.

[ar. 25, inclusive, 1914.

Number and size of ranges.	Gas ranges used.	Cubic feet of heated space.	Number of rooms.	A c fe h s ch a e r
1 No. 4..	No.	40,771	12	
..do....	No.	40,771	12	
..do....	No.	40,771	12	
1 No. 3..	No.	30,683	10	
..do....	No.	30,683	10	
..do....	No.	30,683	10	
..do....	No.	30,683	10	
..do....	No.	30,683	10	
..do....	No.	30,683	10	
..do....	No.	30,683	10	
..do....	No.	30,683	10	
..do....	No.	30,683	10	
..do....	No.	30,683	10	
..do....	No.	30,683	10	
1 No. 5..	No.	152,498	7	
1 No. 3..	No.	10,332	5	
..do....	No.	10,332	5	
..do....	No.	10,332	5	
..do....	No.	10,332	5	
..do....	No.	10,332	5	
..do....	No.	10,332	5	
..do....	No.	10,332	5	
..do....	No.	10,332	5	
..do....	No.	10,332	5	
..do....	No.	10,332	5	
..do....	No.	10,332	5	
..do....	No.	10,332	5	
1 No. 4..	No.	81,972	16	
.....	No.	63,504	16	
1 No. 4..	No.	32,912	4	
..do....	No.	73,968	10	
1 No. 4, 1 No. 5..	No.	104,324	10	
.....	No.	82,392	10	
1 No. 4, 1 No. 5..	No.	249,163	12	
..do....	No.	249,163	12	
..do....	No.	249,163	12	
2 No. 4..	No.	250,600	19	
.....	No.	86,724	12	
.....	No.	[2] 5,206	.....	

, the east plant furnishes power for s

Report of tests on heating boilers, etc., Washington Barracks, Feb. 13 to Mar. 25, inclusive, 1914.

Building.			Name of boiler.	No. of boiler.	Steam or water.	Grate area, square feet.	Coal allowance, pounds per day from chart.		Average amount of coal used per day (pounds).						Size and type of water heater.	Number and size of ranges.	Gas ranges used.	Cubic feet of heated space.	Number of rooms.	Average cubic feet of heated space chargeable to each room.	Pounds coal per cubic foot of heated space and total average coal per day for heating.								Temperatures.					
							February mean outside temperature, 25.32.	March mean outside temperature, 36.68.	For heating.		For cooking.		For water heating.								Actual consumption based on 21.17 mean.	Allowance per chart based on 21.17 mean.	Actual consumption based on 29.9 mean.	Allowance per chart based on 29.9 mean.	Actual consumption based on 31.0 mean.	Allowance per chart based on 31.0 mean.	Actual consumption based on 41.91 mean.	Allowance per chart based on 41.91 mean.	Mean outside for February, 25.32. Mean inside for February.			Mean outside for March, 36.68. Mean inside for March.		
Designation.	Occupied by—	Post No.							February.	March.	February.	March.	February.	March.															7 a. m.	11 a. m.	7 p. m.	7 a. m.	11 a. m.	7 p. m.
																													°	°	°	°	°	°
Field officer	Lieutenant colonel	8A	Gurney	904	Steam	7.16	647	482	334	250	139	148				1 No. 4	No.	40,771	12	3,398	0.0085 346	0.0161 657	0.0076 310	0.0143 583	0.0060 244	0.0128 524	0.0053 218	0.0107 417	61.7	68.7	72.6	67.2	68.9	71.3
Do	Major	7A	do	904	do	7.16	647	482	288	255	123	116				do	No.	40,771	12	3,398	0.0074 303	0.0161 657	0.0083 340	0.0143 583	0.0061 250	0.0128 524	0.0052 214	0.0107 417	63.0	68.0	70.2	65.8	69.1	70.6
Do	do	9A	do	904	do	7.16	647	482	358	315	127	105				do	No.	40,771	12	3,398	0.0094 384	0.0161 657	0.0089 363	0.0143 583	0.0054 319	0.0128 524	0.0067 275	0.0107 417	69.6	71.3	72.9	70.2	69.7	68.0
Do	do	2A	do	902	do	5.03	382	283	366	327	80	105.0				1 No. 3	No.	30,683	10	3,068	0.0119 366	0.0126 388	0.0128 393	0.0112 342	0.0104 319	0.01 307	0.0094 288	0.0078 238	63.5	67.5	71.8	65.4	68.6	71.0
Officer	Captain	1A	do	902	do	5.03	382	283	307	246	98	77.0				do	No.	30,683	10	3,068	0.0098 300	0.0126 388	0.0102 313	0.0112 342	0.0080 244	0.01 307	0.0071 218	0.0078 238	64.0	68.5	73.0	64.6	68.3	63.6
Do	do	4A	do	902	do	5.03	382	283	280	220	80	68.0				do	No.	30,683	10	3,068	0.0090 276	0.0126 388	0.0082 253	0.0112 342	0.0075 231	0.01 307	0.0067 200	0.0078 238	58.7	63.9	72.8	59.8	64.1	66.0
Do	do	5A	do	902	do	5.03	382	283	346	264	72	83.0				do	No.	30,683	10	3,068	0.0111 341	0.0126 388	0.0114 355	0.0112 342	0.0086 263	0.01 307	0.0074 227	0.0078 238	63.1	68.1	71.1	75.6	69.9	70.3
Do	do	6A	do	902	do	5.03	382	283	346	247	77	78.0				do	No.	30,683	10	3,068	0.0112 342	0.0126 388	0.0112 343	0.0112 342	0.0101 309	0.01 307	0.0081 248	0.0078 238	65.7	68.1	71.9	66.0	67.7	68.0
Do	do	10A	do	902	do	5.03	382	283	300	227	94	82.8				do	No.	30,683	10	3,068	0.01 307	0.0126 388	0.0098 300	0.0112 342	0.0069 213	0.01 307	0.0062 191	0.0078 238	61.2	68.5	70.8	61.5	69.2	70.9
Do	do	12A	do	902	do	5.03	382	283	376	273	93	112.0				do	No.	30,683	10	3,068	0.0123 376	0.0126 388	0.0121 370	0.0112 342	0.0084 256	0.01 307	0.0073 234	0.0078 238	61.5	68.4	72.3	67.3	69.6	72.6
Do	First lieutenant	3A	do	902	do	5.03	382	283	270	220	81	94.5				do	No.	30,683	10	3,068	0.0092 283	0.0126 388	0.0096 293	0.0112 342	0.0075 231	0.01 307	0.0056 173	0.0078 238	61.5	65.6	70.3	61.9	65.0	68.0
Do	do	11A	do	902	do	5.03	382	283	311	223	90	79.0				do	No.	30,683	10	3,068	0.0106 325	0.0126 388	0.0096 295	0.0112 342	0.0069 213	0.01 307	0.0059 182	0.0078 238	51.1	59.9	66.1	60.1	64.2	66.8
Do	do	13A	do	902	do	5.03	382	283	222	265	130	108.0				do	No.	30,683	10	3,068	0.011 338	0.0126 388	0.0092 283	0.0112 342	0.0094 288	0.01 307	0.0077 236	0.0078 238	60.7	64.3	68.9	62.6	65.7	65.2
Do	9 first lieutenants	15A	do	902	do	5.03	382	283	467	308	89	118.0				do	No.	30,683	10	3,068	0.0146 446	0.0126 388	0.0146 448	0.0112 342	0.0121 372	0.01 307	0.0109 336	0.0078 238	53.1	61.1	66.9	60.8	68.3	73.2
Officers' club		16A	do	1,200	do	1,932	1,776	1,327	750	559	201	164				1 No. 5	No.	152,498	7	21,785	785	1,822	725	1,595	525	1,437	575	1,150	67.8	69.9	70.9	65.6	69.1	70.6
Noncommissioned officers' quarters	Noncommissioned officers	28A	Latrobe		Latrobe	0.78+			54.4	50.0	65.6	50.0				1 No. 3	No.	10,332	5	2,066	54.6		57.5		46.9		47.7		61.5	69.1	71.6	71.6	73.0	75.6
Do	do	28B	do		do	0.78+			56.0	51.0	67.2	51.0				do	No.	10,332	5	2,066	63.0		57.5		53.1		49.0		68.4	70.5	72.0	70.4	61.7	73.5
Do	do	29A	do		do	0.78+			61.5	38.0	53.7	42.0				do	No.	10,332	5	2,066	60.6		50.0		43.7		31.8		57.0	61.8	67.5	60.5	64.4	68.2
Do	do	29B	do		do	0.78+			58.1	78.9	58.4	50.0				do	No.	10,332	5	2,066	62.9		57.5		56.3		43.2		73.7	76.5	70.3	73.2	71.0	75.9
Do	do	30A	do		do	0.78+			70.9	44.0	62.4	54.0				do	No.	10,332	5	2,066	73.7		70.0		46.9		25.0		59.1	63.1	66.2	62.0	65.2	67.1
Do	do	30B	do		do	0.78+			52.8	36.0	50.0	40.0				do	No.	10,332	5	2,066	60.2		40.0		34.5		31.8		62.1	69.4	72.5	64.3	70.7	72.9
Do	do	31A	do		do	0.78+			65.3	43.0	76.8	53.0				do	No.	10,332	5	2,066	72.5		47.5		53.2		31.8		62.2	74.5	70.8	68.8	71.0	75.3
Do	do	31B	do		do	0.78+			56.5	52.0	69.0	57.0				do	No.	10,332	5	2,066	60.8		60.0		46.9		45.4		67.1	72.9	71.5	70.9	71.1	75.6
Do	do	34A	do		do	0.99+			74.0	50.0	85.0	66.0				do	No.	10,332	5	2,066	81.9		50.0		50.0		50.0		56.5	62.6	65.1	59.5	63.7	64.1
Do	do	34B	do		do	0.99+			84.7	48.0	65.3	57.0				do	No.	10,332	5	2,066	87.1		70.0		56.3		34.1		71.5	83.3	81.7	77.1	81.9	87.8
Do	do	35A	do		do	0.99+			67.1	41.0	52.3	48.0				do	No.	10,332	5	2,066	72.7		62.5		71.9		47.7		50.7	60.2	62.8	53.0	62.0	63.3
Do	do	35B	do		do	0.99+			60.9	54.0	78.0	54.0				do	No.	10,332	5	2,066	62.5		57.5		50.0		51.6		68.1	75.4	74.2	71.8	76.2	75.1
School building		2	Gurney	1023	Steam	8.56	786	587	438	242	63.8	63.0				1 No. 4	No.	81,972	16	5,124	413	807	383	706	212	587	196	513	61.9	68.7	68.1	66.4	68.4	68.2
Headquarters		3	do	1024	do	8.56	786	587	537	436							No.	63,504	16	3,970	511	807	605	706	514	587	286	513	61.7	65.7	67.6	62.2	64.1	67.2
Guardhouse		32A	Dunning	3½	do	5.39	414	311	401	404	273	259				1 No. 4	No.	32,912	4	8,228	383	423	118	371	484	332	306	260	58.1	61.2	62.5	62.4	62.9	64.4
Post exchange		36A	Century	18	do	8.75	806	603	234	153	695	109	79.8	57.6	Tabasco No. 300	do	No.	73,968	10	7,396	252	825	157	721	144	651	113	501	50.2	56.1	57.6	58.4	61.2	60.0
Bakers' school [1]		26A	Central plant	4 Keeler 75 horsepower return tubular boilers.	do	4 boilers, each 24 square feet.			8,970 E, 7,200 W, Total.... 16,170	10,040 E, 4,260 W, Total.... 14,300	426	225				1 No. 4, 1 No. 5	No.	104,324	10	10,132	8,790 E, 7,530 W, Total.... 16,320		10,040 E, 6,835 W, Total.... 16,875		10,730 E, 3,665 W, Total.... 14,395		9,130 E, 3,745 W, Total.... 12,875		68.8	73.7	77.6	68.8	75.8	70.4
Band barracks [1]	Band	17	do		do						130	111					No.	82,392	10	8,239												61.3	65.9	65.8
Barracks [1]	Company A		do		do						484	545	Water heated from central power plant.			1 No. 4, 1 No. 5	No.	249,163	12	20,763									60.2	63.9	65.6	61.7	65.3	66.9
Do. [1]	Company B		do		do						484	545				do	No.	249,163	12	20,763									57.7	58.8	62.1	64.5	62.2	66.0
Do. [1]	Company C		do		do						496	518	426	610	Our own No. 54	do	No.	249,163	12	20,763									58.2	62.2	60.2	59.1	62.0	60.4
Do. [1]	Company D		do		do						572	687			Circulator No. 30	2 No. 4	No.	250,600	19	13,190									50.8	61.6	65.5	58.8	58.5	62.3
Hospital [1]			do		do												No.	86,724	12	7,225									58.9	63.2	66.5	61.3	63.1	61.4
2 storehouses [1]	Engineer storehouse, quartermaster, and commissary.	20A, 21A	do		do												No.	[2] 5,206											(3)	(3)	(3)	(3)	(3)	(3)

NOTE.—Central power plant furnishes approximately 15 boiler horsepower for sewage ejector in addition to heating.

[1] All these buildings heated by two central heating plants equipped with two 75 horsepower Keeler return tubular boilers. These plants are operated in parallel. In addition to heating, the east plant furnishes power for sewage ejector, air compressor, an average load of approximately 15 boiler horsepower.

[2] Square feet radiating surface.

[3] No temperatures taken in storehouses.

4. Accompanied by the civilian employee who is in charge of heating plants at Fort Myer, and the first to report of the non-commissioned officers who were deatiled for duty in connection with the fuel tests, an inspection of heating plants was begun on this date. The following buildings were visited on this date: administration, guardhouse, band barrack, post exchange, five double sets of officers' quarters, the post hospital and contagious hospital, three artillery barracks, and two double cavalry barracks.

5. Notes were made in connection with each installation, and included a description of the apparatus and of its condition. The type, make, and manufacturers' number of heating boiler was noted, the type of heating system, whether steam or hot water, and the type and condition of damper regulator. Note was also made as to whether the boiler was provided with check draft in the smoke pipe. The size and number of cooking ranges was noted. Where quarters are provided with gas ranges, note was made of this fact and an inquiry was made as to the extent to which gas range was used. Where hot-water heaters are provided in barracks, etc., note was made of the size and make of same. The above information in reagrd to existing equipment, and with the exception of information in regard to damper regulator and check draft, appears on the tabulated statement of results of fuel test at Fort Myer, a copy of which is herewith.

6. Heating boilers were examined to see if water line was carried at proper height, the condition of flue passages and the thickness and condition of fire was noted, the ash pit was examined, note was made of the condition of damper regulator, and if a pressure of over 5 pounds per square inch was indicated by gauge note was made of that fact.

7. The condition in which heating boilers were found was uniformly bad. Tubes and flues had apparently not been cleaned for months prior to this inspection. In the case of boilers of the Dunning type, the opening of clean-outs in the base of boiler often resulted in a mass of soot and flue dust falling out upon the floor. In the case of boilers of the Century type the horizontal fire tubes were, without exception, badly in need of cleaning. A particularly bad instance of this condition was furnished by the boiler in the contagious hospital. In this boiler the two lower rows of tubes were so completely filled with cinders, ash, and soot that there were but 3 tubes out of the 11 in these two rows through which any light could be discerned.

8. All boilers were found to be provided with damper regulators of one type or another, but practically all of them were either disconnected or inoperative, or both. In the case of regulators of the ordinary rubber diaphragm type, many of the diaphragms were found to be leaky and useless. In the case of regulators of the all-metal type the regulators themselves were in good condition, but were either

disconnected altogether from draft doors and check dampers or else connected in such a way as to be useless.

9. In a large majority of the boilers inspected the fire carried was altogether too thick, and the ash pits in several cases showed an excessive accumulation of ashes. Apparently the only method of checking or regulating the steam pressure was by opening the fire door, thus allowing cold air to come in contact with the heating surfaces of the boiler. In a large majority of cases the following conditions were noted: Damper regulator disconnected, check draft closed, chimney damper wide open, ash-pit draft open, fire door open, and no steam pressure on the system. In other words, practically as much coal was being burned as would be required to develop the maximum boiler capacity, but no steam or not enough to show on the gauge was being generated.

10. During the week following the inspection above noted, the writer visited Fort Myer twice, reporting each time to the quartermaster and inspecting the remainder of the heating plants at the post. In the meantime the heating plants were being overhauled and cleaned and certain necessary repairs were being made in order to put the boilers in good operating condition. It was not the purpose or desire of this office to impose conditions upon the heating apparatus which could not and should not be maintained during ordinary operation. It was the intention, however, to place and maintain equipment in good operating condition; and to this end, boilers were cleaned of soot at the start of the test and kept reasonably clean throughout the test. New rubber diaphragms were installed in damper regulators where necessary; damper regulators were properly adjusted and connected to draft doors and check drafts; attention was given to the adjustment of air valves; and, in general, such repairs as were found necessary for good operation were made where possible.

11. On February 14 it was decided that the test could be started on the following morning, Sunday, the 15th. The three non-commissioned officers who were detailed for duty in connection with this test had reported previous to this date and understood their duties, which were the general supervision of the firing in the different plants, and keeping the records of temperatures, coal consumptions, etc. To provide some system for carrying on the test, the post had been divided into three districts, one of which was in charge of each of the non-commissioned officers above mentioned. It was decided to measure coal for heating from the ash cans provided for this purpose, and to record coal used for cooking by recording the number of sacks full used. The coal used for cooking was not recorded until February 18, as same had to be sacked.

12. On February 24 it was decided that it would be better to record the coal used for cooking in the same way as that used for heating.

There was so much variation in the weight of the sacks of coal that it was not believed that this method was as good as the method of measuring coal in cans. Accordingly, this method was followed during the remainder of the test. In addition, a separate record was kept of all coal used for laundry purposes and for fireplaces. All wood on hand was measured and subsequent issues were recorded. Gas meters were read each week. Amounts of coal less than a can full were estimated by the use of a measuring stick equal in length to the inside depth of the can and divided into 10 equal parts. Separate piles of coal for heating and cooking were placed on the basement floor each day, in amount ample for that day's needs and in such locations as to avoid any chance of confusion. On the following day the coal remaining in each pile was measured separately and its amount deducted from the amount in the original pile. In this manner, the daily records were obtained. This method was also followed in keeping the daily record of coal used in water heaters in barracks, hospital, guardhouse, etc. Separate sacks of coal of known weights were placed in the basement of quarters for fireplaces and in the laundry for laundry stoves.

13. In plotting and tabulating the final results, the coal used for the laundry is charged to cooking, and the coal used in fireplaces is charged to heating. The wood used in officers' quarters amounted, when reduced to its equivalent in anthracite coal, to an average of 8 pounds of coal per day for each set of quarters. Where gas was used for cooking it apparently did not affect the amount of coal used, as will be seen from an examination of the tabulation of results herewith. As a matter of fact the amount of gas used, as shown by meter readings, was so small as to be negligible.

14. The average daily amounts of coal used in the ranges of different size, and in water heaters of different sizes was as follows:

	Pounds.
Range No. 3	85
Range No. 5	134
Water heater No. 18	95
Water heaters Nos. 21, 26, and 200	149
Water heater No. 300	240

The above figures are the averages for the whole period of the test, from February 15 to March 25, inclusive, with the exception of figures for ranges. The figures for ranges are averages from February 25 to March 25, inclusive.

15. In reviewing the results of the test under consideration it may be noted that, considering the duration of the test, the weather conditions were exceedingly favorable to the obtaining of conclusive results. The range of daily mean outside temperatures was from +11.9° F. on February 24 to +62° F. on March 25. Furthermore, it

was possible to divide the test into four periods, during which there was considerable variation in the outside temperature. The first period was from February 15 to February 24, inclusive, and during this period the mean outside temperature was 24.71° F.; the second period, from February 25 to March 6, inclusive, had a mean outside temperature of 29.91° F.; the third period, March 7 to March 14, the temperature was 34° F.; and the fourth period, March 15 to March 25, inclusive, the mean outside temperature was 41.9° F., In addition to the varied temperature conditions above mentioned, one period of excessively high wind was experienced. The records for March 2 show a total wind movement of over 900 miles, and the maximum wind velocity during this period was about 65 miles per hour. March 1 and 3 also show excessively high wind movement.

16. On the tabulation and charts herewith are shown the condensed records for the various buildings at the post. From the average inside temperatures for the different buildings it will be seen that no attempt was made to economize on coal at the expense of comfort. In so far as was possible, the desires of the occupants of the different buildings were complied with in this respect. This accounts for the high temperatures which, it will be seen, were maintained in some of the officers' quarters.

17. From the comparison of actual coal consumptions with the proposed chart allowances, it appears that in a large majority of cases the allowance as indicated by the chart is ample for heating buildings which are provided with steam or hot-water heating plants. The boilers tested at Fort Myer are representative of boilers in use throughout the service, there having been included 25 vertical steel boilers of the Dunning or Kewanee type, 5 vertical cast-iron boilers and 15 horizontal steel boilers of the Century or Ideal cylindrical type. From the tabulation and charts herewith, it will be seen that the actual amounts of fuel consumed in boilers of all three types agree remarkably well with the proposed chart allowances.

18. There are with this report four charts showing the line representing the chart allowance for Fort Myer and for large and small size heating boilers. Upon these charts has been plotted a series of points representing the actual rates of combustion recorded for each day of the test and for grates of the sizes noted on charts. It will be seen that in general the allowance line is fairly representative of the points as plotted, except that it is somewhat above a line representing the mean of the points. This is as it should be. It will also be seen that the greatest variation from the allowance line comes in the case of the small grates and on days when the outside temperatures were relatively high. This condition is undoubtedly due in part to the fact that, in direct steam-heating systems, there is a considerable loss of efficiency with high outside tempera-

tures. With high outside temperatures there is also a marked tendency to open outside windows and doors, thus placing a larger load than necessary on the heating system. This condition was met with in several of the quarters at Fort Myer and was undoubtedly responsible for a part of the variation above mentioned. It is believed that additional care in the matter of leaving windows and doors open will correct this variation to a considerable extent. It is also to be expected that a continuation of weather as mild as some that was experienced during this test will result in the drawing of fires in heating boilers, thus offsetting any excess in coal consumption which may develop when the fire is maintained.

19. In conclusion, it may be noted that the fuel in use during this test was Pennsylvania anthracite coal. It is believed that with the exercise of proper and reasonable care in the operation of heating boilers, the amounts of coal provided by the charts will be found to be sufficient. It may be further remarked that if coal consumption is to be kept within the chart allowance, proper and reasonable care in the use of fuel must be exercised. Where coal of a lower grade than the above is used, due allowance for the heating value of same should be made.

20. In regard to coal for cooking in officers' quarters, an allowance of 90 pounds per day is recommended. This is 5 pounds in excess of the average used in No. 3 ranges at Fort Myer. The margin is not large, but it is to be noted that during the severe weather prevailing throughout a large part of the test a certain indeterminate amount of coal was used in the ranges for heating the kitchen. During the summer months the tendency will be to use as little coal for cooking as possible, and the writer believes the allowance as above recommended will be found to be sufficient.

21. For cooking in barracks an average of 134 pounds per day in the No. 5 range was used. Based on the number of men in the organizations the coal for cooking averaged 2.93 pounds per man per day. In three of the seven organizations at Fort Myer the use of coal for cooking was in excess of 3.5 pounds of coal per day. It is recommended that the allowance of coal for cooking in barracks be fixed at 3.5 pounds of coal per man per day, it being believed that during the hot weather the use of coal in ranges in barracks will be considerably decreased. For cooking in noncommissioned officers' quarters it is believed that the winter allowance should be somewhat in excess of the summer allowance, since kitchens are used more or less as living rooms and it is necessary to burn some coal in ranges for the purpose of heating the room. It is believed that 75 and 50 pounds of coal per day, respectively, would represent fair allowances for each of the eight winter and four summer months.

22. For water heaters it is recommended that the allowances be fixed as follows:

For heaters—	Pounds per day.
Nos. 150, 17, and 18	100
Nos. 200, 21, and 22	150
Nos. 300, 25, 26, and 27	250

These figures are somewhat in excess of the average actual consumptions at Fort Myer in each case.

23. There are forwarded herewith four copies of this report and five copies each of 14 charts and one tabulation; 79 inclosures.

Respectfully submitted.

L. H. TRIPP,
Sanitary and Heating Engineer.

Average costs in Washington, using gas for fuel for officers on commutation status, January to December, 1913.

Rank of officer.	Number of officers each rank.	Number of rooms.		Cost of gas for fuel per annum.			Average cost per month.
		Actually occupied average (a).	Allowance (b).	Total cost (c).	Cost per room $(d)=\frac{c}{a}$.	Total cost on basis regular allowance of rooms $(e)=d\times b$.	
Major general	1	20	9	29.41	1.47	13.23	2.45
Brigadier general	3	16	8	91.75	5.73	45.84	7.65
Colonel	5	8	7	31.20	3.90	27.30	2.60
Lieutenant colonel	1	9	6	72.93	8.10	48.60	6.08
Major	11	$8\frac{10}{11}$	5	23.32	2.62	13.10	1.94
Captain	11	$7\frac{10}{11}$	4	40.98	5.18	20.72	3.42
Lieutenant	3	6	3	12.44	2.07	6.21	1.04

NOTE.—The above table applies to 35 officers who have been using gas for fuel for a full 12 months' period. Officers having received service for only a fraction of a year, or those for which the number of rooms occupied is not known, have not been considered in making up this statement.

TREASURY DEPARTMENT,
Washington, April 7, 1914.

The honorable the SECRETARY OF WAR,
Washington, D. C.

SIR: By direction of the Secretary I have the honor to advise you, in reply to your letter of the 31st ultimo in reference to the quantity of fuel required to heat private residences, that the method of computing the coal consumption of any given building varies, depending upon the different methods of construction used and upon the skill of firemen employed.

Under average conditions in the latitude of Washington, D. C., assuming that the average size of a residence room is 12 by 14 by 9 feet 6 inches and will contain a 50-square foot hot-water radiation, the coal consumption may be checked by the following rules of thumb,

Mar. 25, inclusive, 1914.

Numbers and size of ranges.	Gas ranges used.	Cubic feet of heated space.	Number of rooms.
1 No. 5..	No....	39,634	11
1 No. 3..	Yes...	33,997	10
1 No. 3..	Yes...	30,635	9
1 No. 3..	No....	29,016	9
1 No. 3..	None..	29,016	9
1 No. 3..	Yes...	23,599	8
1 No. 3..	None..	23,599	8
1 No. 3..	None..	23,599	8
1 No. 3..	None..	23,599	8
1 No. 3..	No....	23,599	8
1 No. 3..	No....	23,599	8
1 No. 3..	Yes...	23,599	8
1 No. 3..	No....	23,599	8
1 No. 3..	None..	26,354	7
1 No. 3..	Yes...	26,354	7
1 No. 3..	Yes...	26,354	7
1 No. 3..	None..	26,354	7
1 No. 3..	Yes...	23,386	7
1 No. 3..	Yes...	23,386	7
1 No. 3..	Yes...	23,386	7
1 No. 3..	No....	23,386	7
1 No. 3..	None..	23,386	7
1 No. 3..	None..	23,386	7
1 No. 3..	None..	16,380	5
1 No. 3..	None..	16,380	5
1 No. 3..	No....	16,380	5
1 No. 3..	None..	16,380	5
.....	None..	25,412	8
1 No. 5..	None..	72,010	16

Building.			Name of boiler.	No. of boiler.	Steam or water.	Grate area (square feet).	Coal allowance, pounds per day from chart.		Average amount of coal used per day (pounds).				Size and type of water heater.	Numbers and size of ranges.	Gas ranges used.	Cubic feet of heated space.	Number of rooms.	Average cubic feet of heated space chargeable to each room.	Pounds coal per cubic foot of heated space and total average coal per day for heating.								Temperatures.					
									For heating.		For cooking.		For water heating.													Mean outside for February, 25.87.			Mean outside for March, 36.68.		
Designation.	Occupied by.	Post and plan No.					February mean outside temperature, 25.87.	March mean outside temperature, 36.68.	February.	March.	February.	March.	February.	March.						Actual consumption based on 24.71 mean.	Allowance per chart based on 24.71 mean.	Actual consumption based on 29.91 mean.	Allowance per chart based on 29.91 mean.	Actual consumption based on 34.0 mean.	Allowance per chart based on 34.0 mean.	Actual consumption based on 41.39 mean.	Allowance per chart based on 41.91 mean.	Mean inside for February.			Mean inside for March.		
																										7 a. m.	11 a. m.	7 p. m.	7 a. m.	11 a. m.	7. p. m.
Commanding officer's quarters	Colonel	1(95A)	Palmer Dunning type		Steam	4.28	324	244	313	215	127	113		1 No. 5	No	39,634	11	3,603	0.0084	0.0084	0.0067	0.0071	0.0054	0.0067	0.0049	0.0052						
																			328	332	264	282	214	264	193	206	64.0	67.0	68.0	64.0	65.2	67.8
Quarters for field officers	Captain	92(145F)	New Dunning elongate.	304	do	4.28	324	244	330	309	84	103		1 No. 3	Yes	33,997	10	3,400	0.0100	0.0098	0.0110	0.0087	0.0093	0.0078	0.0083	0.0081						
																			340	332	342	294	305	264	284	266	63.0	63.0	67.0	63.3	65.1	67.8
Officers' quarters	Major	80(145)	Kewanee vertical	550	do	3.69	279	211	345	284	62	64		1 No. 3	Yes	30,635	9	3,400	0.0116	0.0094	0.0106	0.0083	0.0093	0.0075	0.0083	0.0078						
																			355	286	324	254	282	228	254	177	71.0	70.0	78.5	70.0	74.1	77.4
Double quarters for officers	Captain	77a(142A)	Regular Dunning	2½	do	3.69	279	211	329	208	135	89		1 No. 3	No	29,016	9	3,224	0.0084	0.0099	0.0075	0.0087	0.0073	0.0079	0.0067	0.0061						
																			243	286	216	253	212	228	193	177	67.1	71.3	73.0	70.1	72.8	74.8
Do	Major	77b(142A)	do	2½	do	3.69	279	211	289	196	105	65		1 No. 3	None	29,016	9	3,224	0.0084	0.0099	0.0083	0.0087	0.0064	0.0079	0.0066	0.0061						
																			243	286	183	253	191	228	192	177	66.0	71.0	73.0	69.8	72.7	75.6
Double set officers' quarters	Lieutenant	15a(90)	New Dunning elongate.	304	do	4.28	324	244	310	211	104	61		1 No. 3	Yes	23,599	8	2,950	0.0101	0.0141	0.0104	0.0125	0.0083	0.0142	0.0088	0.0085						
																			216	332	236	294	193	264	193	206	69.0	72.4	71.3	70.5	73.0	75.9
Do	Captain	15b(90)	do	304	do	4.28	324	244	236	211	108	72		1 No. 3	None	23,599	8	2,950	0.0103	0.0141	0.0104	0.0125	0.0083	0.0142	0.0082	0.0085						
																			243	332	240	294	195	264	193	206	67.8	72.0	74.0	70.9	73.2	75.0
Do	do	16a(90)	Regular Dunning	3	do	4.28	324	244	242	201	132	81		1 No. 3	None	23,599	8	2,950	0.0105	0.0142	0.0082	0.0125	0.0083	0.0142	0.0082	0.0085						
																			219	332	246	294	195	264	191	206	66.8	70.4	74.3	69.2	71.8	74.0
Do	do	16b(90)	do	3	do	4.28	324	244	241	194	117	68		1 No. 3	None	23,599	8	2,950	0.0101	0.0142	0.0101	0.0125	0.0087	0.0142	0.0076	0.0085						
																			216	332	215	294	205	264	178	206	66.0	71.2	74.0	69.0	72.3	75.1
Do	Doctor	17a(90)	New Dunning elongate.	304	do	4.288	324	244	260	217	117	68		1 No. 3	No	23,599	8	2,950	0.0115	0.0142	0.0096	0.0125	0.0097	0.0142	0.0086	0.0085						
																			272	332	226	294	229	264	203	206	68.1	68.2	72.8	68.3	71.5	74.3
Do	Captain	17b(90)	Regular Dunning	3	do	4.28	324	244	241	196	105	87		1 No. 3	No	23,599	8	2,950	0.0103	0.0141	0.0092	0.0125	0.0082	0.0142	0.0082	0.0085						
																			243	332	218	294	193	264	192	206	66 3	70.5	73.7	69.1	72.2	75.4
Do	do	18a(90)	do	3	do	4.28	324	244	260	214	125	70		1 No. 3	Yes	23,599	8	2,950	0.0116	0.0142	0.0095	0.0125	0.0083	0.0142	0.0093	0.0085						
																			274	332	226	294	193	264	219	206	68.1	69.2	73.7	68.2	71.3	74.6
Do	do	18b(90)	do	3	do	4.28	324	244	222	196	105	74		1 No. 3	No	23,599	8	2,950	0.0104	0.0142	0.0078	0.0125	0.0079	0.0142	0.0083	0.0085						
																			246	332	184	294	187	264	200	206	67.0	69.4	73.0	67.7	71.7	73.0
Do	do	44a(10)	Arco	1-28-5	do	4.12	311	235	298	266	90	95		1 No. 3	None	26,354	7	3,765	0.0118	0.0126	0.0113	0.0107	0.0100	0.0096	0.0096	0.0078						
																			311	349	299	283	266	254	226	198	70.0	78.0	70.8	72.9	70.1	70.4
Do	Major	44b(10)	Model	22–5	do	4.28	324	244	348	264	118	113		1 No. 3	Yes	26,354	7	3,765	0.0107	0.0126	0.0117	0.0107	0.0100	0.0096	0.0096	0.0078						
																			283	349	308	283	263	254	252	198	70.0	71.0	71.0	71.8	73.1	74.0
Do	Captain	45a(10)	do	22–5	do	4.28	324	244	304	266	121	95		1 No. 3	Yes	26,354	7	3,765	0.0118	0.0126	0.0117	0.0107	0.0097	0.0096	0.0092	0.0078						
																			311	332	307	283	256	254	242	206	68 0	72 0	73.5	70.6	74.5	76.1
Do	do	45b(10)	do	22–5	do	4.28	324	244	282	252	94	93		1 No. 3	None	26,354	7	3,765	0.0108	0.0126	0.0114	0.0107	0.0092	0.0096	0.0088	0.0078						
																			284	332	300	283	243	254	223	206	72.5	75.0	77.0	72.8	73.0	76.2
Quarters for 2 lieutenants	Lieutenant	91a(120H)	New Dunning elongate.	303	do	3.69	279	211	244	209	91	87		1 No. 3	Yes	23,386	7	3,341	0.0105	0.0122	0.0109	0.0108	0.0087	0.0097	0.0077	0.0076						
																			246	286	256	253	203	226	179	177	59.0	63.0	67.5	58.8	63.7	68.1
Do	do	91b(120H)	do	303	do	3.69	279	211	271	250	60	76		1 No. 3	Yes	23,386	7	3,341	0.0120	0.0122	0.0115	0.0108	0.0069	0.0097	0.0098	0.0076						
																			280	286	270	253	254	226	224	177	67.0	68.0	70.0	69.3	66.9	68.0
Do	do	93a(120H)	do	303	do	3.69	279	211	245	203	135	77		1 No. 3	Yes	23,386	7	3,341	0.0100	0.0122	0.0101	0.0108	0.0077	0.0097	0.0083	0.0076						
																			254	286	236	253	180	226	198	177	69.0	71.5	75.0	70.4	73.0	77.2
Do	do	93b(120H)	Furman, round	25–2	do	3.41	258	193	236	198	152	85		1 No. 3	No	23,386	7	3,341	0.0106	0.0143	0.0094	0.0100	0.0086	0.0090	0.0076	0.0070						
																			249	336	220	234	206	212	179	164	64.0	70.3	72.0	68.3	70.9	72.4
Do	do	94a(120H)	New Dunning elongate.	303	do	3.69	279	211	221	210	116	67		1 No. 3	None	23,386	7	3,341	0.0093	0.0122	0.0099	0.0108	0.0094	0.0097	0.0066	0.0070						
																			218	286	241	253	220	226	155	177	63.5	69.5	72.5	70.3	73.2	75.3
Do	do	94b(120H)	do	303	do	3.69	279	211	209	183	110	98		1 No. 3	None	23,386	7	3,341	0.0093	0.0122	0.0097	0.0108	0.0091	0.0097	0.0076	0.0076						
																			217	286	204	253	202	226	180	177	68.0	71.0	74.0	69.0	71.0	73.6
Double set officers' quarters	do	78a(120C)	Kewanee vertical	400	do	3.14	237	179	236	172	115	67		1 No. 3	None	16,380	5	3,276	0.0132	0.0148	0.0122	0.0132	0.0099	0.0148	0.0101	0.0092						
																			279	243	200	216	163	194	165	151	65.5	69.5	71.0	69.2	71.9	73.0
Double set officers' quarters (unoccupied)	do	78b(120C)	do	400	do	3.14	237	179						1 No. 3	None	16,380	5	3,276		0.0148		0.0132		0.0148	0.0103	0.0092						
																				243		216		194		151						
Double set officers' quarters	Doctor	79a(120C)	do	400	do	3.14	237	179	208	179	124	74		1 No. 3	No	16,380	5	3,276	0.0129	0.0148	0.0125	0.0132	0.0097	0.0148	0.0102	0.0092						
																			242	243	216	216	159	194	156	151	66.5	71.5	73.5	68.4	71.6	73.5
Do	Lieutenant	79b(120C)	do	400	do	3.14	237	179	222	181	119	80		1 No. 3	None	16,380	5	3,276	0.0134	0.0148	0.0126	0.0132	0.0122	0.0148	0.0099	0.0092						
																			220	243	206	216	201	194	152	151	65.5	71.0	77.5	68.8	71.0	72.8
Bachelor officers		86 East	Regular Dunning	3	do	4.28	324	244	334	285			88	83	Tabasco, No. 18		None	25,412	8	3,178	0.0078	0.0131	0.0120	0.0110	0.0115	0.0104	0.0104	0.0081						
																			350	332	304	291	292	264	264	206	67.1	68.3	69.0	61.8	60.6	65.8
Do		86 C	do	4½	do	7.87	714	540	598	577	203	178	105	111	do	1 No. 5	None	72,010	16	4,501	0.0083	0.0102	0.0091	0.0079	0.0082	0.0084	0.0082	0.0083						
																			378	459	655	570	591	586	591	453	68.8	69.1	71.3	63.6	65.4	68.7
Do		86 West	do	3	do	4.28	321	244	338	309			80	95	do		None	25,412	8	3,178	0.0129	0.0131	0.0127	0.0116	0.0122	0.0101	0.0115	0.0081						
																			353	332	322	294	310	264	293	206	68.1	68.8	72.2	69.0	73.1	75.8
Noncommissioned officers	Civilian clerks	5	Stoves						30	31	60	59		1 No. 3		9,694	6	1,616														
Do	Sergeant major	6	do						48	51	64	59		1 No. 8A		7,802	6	1,300														
Double set noncommissioned officers	Chief musician	29a(82)	do								90	76		1 No. 3		5,980	4	1,495														
	Reg. Qm. Sct	29b(82)	do						34	30	84	76		1 No. 3	None	5,980	4	1,495														
Noncommissioned officers	Ordnance sergeant	37	do						80	81	54	75		1 No. 6		7,359	6	1,224														
Do	Sergeant major	51a	do						80	28	113	26		1 No. 3		12,064	5	1,206														
Do	Sergeant	51b	do						30	41	55	40		1 No. 3		12,064	5	1,206														
Administration		7	Ideal, cylindrical	3000	Steam	14.00	1,270	962	889	671							None			849	1,307	781	1,156	691	1,065	561	807	65.5	69.2	70.9	68.4	70.8	72.8
Guardhouse		8	do	1800	do	8.75	794	601	712	551			83.5	75	Tabasco, No. 200		None			735	815	644	973	598	817	595	504	64.3	68.3	69.6	64.3	70.5	72.0
Hospital and annex		32	2 Ideal, cylindrical	3000	Hot water	28.00	2,540	1,924	1,415	1,326	172	188	219	206	Perfect, No. 26	1 No. 4	None			1,273	2,606	1,599	2,312	1,552	2,599	1,552	1,644	64.8	70.4	70.5	69.2	70.4	70.8
Quartermaster's storehouse		67	Dunning	3	Steam	5.24	390	296	324	297							None			231	406	345	360	320	324	249	282	61.6	73.5	78.0	69.1	72.9	74.3
Post exchange		81	Century	30	do	14.00	1,270	962	737	518	126	156	133	94	Tabasco, No. 200	1 No. 5	None			745	1,304	661	1,156	566	1,065	607	807	65.5	69.6	68.5	68.2	71.4	74.4
Isolation hospital		88	do	18	Hot water	8.75	794	601	564	531			139	53	do		None			595	815	625	973	574	817	595	504	68.4	70.2	71.0	66.8	69.4	71.5
Band quarters		61	do	15	Steam	7.50	680	515	722	590	146	178	122	88	do	1 No. 4	None			700	1,176	673	1,040	674	1,176	554	478	442	64.1	65.5	70.3	64.5	69.3	72.5
Double Cavalry barracks	Troop I	53a	Ideal, cylindrical	2600	do	12.00	1,088	825	1,213	854	301	307	220	197	Tabasco, No. 201	2 No. 5	None			1,075	1,117	1,141	992	973	887	627	692	65.7	70.2	74.5	68.3	70.6	73.4
Do	Troop K	53b	do	2600	do	12.00	1,088	825	1,092	862	293	327	189	191	Tabasco, No. 209	2 No. 5	None			1,047	1,117	1,042	992	938	887	667	692	63.3	66.0	69.0	66.8	68.7	71.1
Do	Troop L	53c	do	2600	do	12.00	1,088	825	1,020	857	393	346	145	225	do	2 No. 5	None			1,047	1,117	1,042	992	938	887	667	692	64.2	66.8	70.7	68.4	68.2	70.3
Do	Troop M	53d	do	2600	do	12.00	1,088	825	1,115	827	255	259	149	181	do	2 No. 5	None			1,132	1,117	1,127	992	933	887	584	692	59.7	64.8	69.6	61.1	67.0	68.0
Artillery barracks	Battery D	75	Century	45	do	17.50	1,588	1,202	1,497	990	237	437	248	235	Tabasco, No. 300	4 No. 5	None			1,483	1,630	1,373	1,445	1,143	1,294	785	1,008	58.7	60.9	66.8	60.4	62.0	67.0
Do	Battery E	74	do	45	do	17.50	1,588	1,202	1,356	950	323	399	236	215	do	4 No. 5	None			1,330	1,630	1,388	1,445	996	1,294	707	1,008	58.7	60.9	66.8	61.9	63.0	66.0
Do	Battery F	95	2 Ideal, cylindrical	2300	do	24.00	2,176	1,650	1,626	1,348	299	459	259	260	do	4 No. 5	None			1,641	2,234	1,642	1,984	1,603	1,774	982	1,384	62.5	66.2	71.3	65.0	64.6	69.2

Buildin	Designation.	Average cubic feet of heated space chargeable to each room.	Temperatures.					
			Mean outside for February, 21.14.			Mean outside for March, 31.78.		
			Mean inside for February.			Mean inside for March.		
			7 a. m.	11 a. m.	7 p. m.	7 a. m.	11 a. m.	7 p. m.
			°	°	°	°	°	°
	Officers' quarters	4,004	65.8	72.9	73.7	70.1	71.8	71.9
	Do	3,524	62.6	71.9	74.5	69.0	72.9	77.3
	Do	3,524	62.1	68.9	70.8	63.3	65.7	70.0
	Do	3,606	64.6	73.3	74.0	66.6	72.6	74.3
	Do	3,606	65.6	69.8	67.3	68.8	69.8	71.0
	Do	3,606	64.4	76.4	76.2	66.5	72.8	72.7
	Do	3,606	76.6	74.4	75.9	67.0	75.2	78.0
	Do	3,606	60.9	66.5	70.4	61.2	70.6	71.4
	Do	.....	67.0	71.2	72.7	68.8	71.0	72.4
	Assembly hall and mess	7,231	66.1	72.0	71.4	67.6	64.2	64.6
	3 officers' quarters	6,126	66.5	73.7	73.1	66.1	75.5	75.9
	Noncommissioned officers	2,115	66.4	71.6	74.5	69.7	73.5	72.4
	Do	2,115	68.3	73.7	71.4	69.4	77.8	78.4
	Do	2,289	62.4	67.4	72.3	62.6	67.4	71.2
	Do	2,289	65.4	69.6	74.4	68.6	73.7	77.0
	Do	2,289	59.5	66.0	68.4	61.8	69.4	72.3
	Do	2,289	63.2	54.6	65.5	60.7	56.3	57.2
	Do	3,501	57.7	62.0	60.1	60.6	60.8	60.7
	Do	3,501	60.5	71.1	74.9	58.1	71.7	75.1
	Do	3,501	62.2	65.0	67.9	66.2	69.2	69.3
	Do	3,501	51.8	61.4	66.4	61.6	66.6	68.4
	Do	2,036	60.1	69.3	69.1	67.0	71.4	72.0
	Do	2,036	61.6	69.4	69.1	66.1	69.0	73.5
	Do	2,065	68.4	74.6	75.0	59.7	73.1	74.0
	Do	1,807	64.4	71.3	70.9	61.2	71.1	78.9
	Do	2,416	69.3	74.5	76.6	78.7	75.9	73.7
	Do	2,394	65.7	76.6	76.0	67.8	73.8	75.2
	Do	289	65.5	67.0	67.3	65.3	54.5	66.7
	Hospital	.....	67.3	70.3	70.0	69.7	69.9	67.1
	Guard house	20,848	61.7	70.0	70.4	67.6	71.5	72.2
	Post exchange and gymnasium.							
	Mounted-gun platoon							
	Tower							
	Infantry barracks	.....	67.4	70.6	65.1	67.9	67.5	67.2
	Kitchens and mess	.....	69.7	70.0	70.6	68.4	69.6	78.8
	Do							
	Do							
	Do							
	Do							
	Do							
	Commissary and quartermaster's storehouse.	.....	56.6	78.0	78.8	54.4	73.9	74.9
	Quartermaster's storehouse	.....	67.9	72.4	70.3	64.8	70.5	71.7
	Pumping station	.....	61.4	62.3	63.2	55.0	56.8	53.1
	Cavalry barracks	10,036	66.8	68.5	68.3	67.7	67.3	68.5
	Do	10,036	61.4	68.1	71.5	63.7	68.3	70.1
	Do	10,036	63.4	69.6	69.5	67.3	69.5	69.4
	Do	10,036	70.9	74.1	74.0	65.1	69.7	71.7

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Building.			Name of boiler.	No. of boiler.	Steam or water.	Grate area, square feet.	Coal allowance pounds per day from chart.		Average amount of coal used per day (pounds).				Cubic feet of heated space.	Number of rooms.	Average cubic feet of heated space chargeable to each room.	Temperatures					
							February mean outside temperature, 21.14.	March mean outside temperature, 31.78.	For heating.		For cooking.					Mean outside for February, 21.14.			Mean outside for March, 31.78.		
																Mean inside for February.			Mean inside for March.		
Designation.	Post No.	Occupied by							February.	March.	February.	March.				7 a. m.	11 a. m.	7 p. m.	7 a. m.	11 a. m.	7 p. m.
																°	°	°	°	°	°
Officers' quarters	76	Major	New Dunning	3½	Steam	5.24	384	302	318	317	153	107	49,046	10	4,004	65.8	72.9	73.7	70.1	71.8	74.9
Do	94a	Captain	Regular Dunning	2½	do	3.69	270	212	262	308	76	73	28,107	8	3,524	62.6	74.9	74.5	69.0	72.9	77.3
Do	93b	do	do	2½	do	3.69	270	212	355	255	57	42	28,197	8	3,524	62.1	68.9	70.8	63.3	65.7	70.0
Do	15	Lieutenant	New Dunning	2½	do	3.69	270	212	262	218	114	98	25,237	7	3,606	64.6	73.3	74.9	66.6	72.6	74.3
Do	3	do	do	2½	do	3.69	270	212	362	277	95	84	25,237	7	3,606	65.6	69.8	67.3	68.8	69.8	71.0
Do	22	do	do	2½	do	3.69	270	212	355	184	95	84	25,237	7	3,606	64.4	76.4	76.2	66.5	72.8	72.7
Do	23	Major	Kewanee	35	do	3.68	270	212	355	222	76	67	25,237	7	3,606	70.6	74.1	75.9	67.0	75.2	78.0
Do	24	First lieutenant	New Dunning	2½	do	3.69	270	212	262	197	57	59	25,237	7	3,606	69.9	66.5	70.4	61.2	70.6	71.4
Do	95b	do	Regular Dunning	2	do	3.14	230	181	224	189	114	75				67.0	71.2	72.7	68.8	71.0	72.4
Assembly hall and mess	31		2 Haxtun	1000	do	9.82	719	566	617	614	419	358	111,623	20	7,231	66.1	72.0	71.4	67.6	64.2	64.6
3 officers' quarters	31		3 New Dunnings	4	do	26.72	2,340	1,827	1,121	1,230			147,031	24	6,126	66.5	73.7	73.1	66.1	75.5	75.9
Noncommissioned officers	45a	First sergeant	Mueller hot-air furnace	248	Hot air	3.64	266	210	56	77	76	59	8,460	4	2,115	66.4	74.6	74.5	69.7	73.5	72.1
Do	45b	do	do	248	do	3.64	266	210	205	119	111	101	8,460	4	2,115	68.3	73.7	71.4	69.1	77.8	78.4
Do	46a		Ideal Arco	1-19-S	Steam	1.76	129	101	114	84	57	42	11,446	5	2,289	62.4	67.4	72.3	62.6	67.4	74.2
Do	46b		Triumph 21-inch	4	do	2.40	176	138	96	85	57	39	11,446	5	2,289	65.4	69.6	71.4	68.9	73.7	77.0
Do	52a	First sergeant	Stoves		Stoves				112	133	95	131	11,446	5	2,289	59.5	66.0	68.1	61.8	69.4	72.3
Do	52b	do	do		do				95	83	75	50	11,446	5	2,289	63.2	51.6	65.6	60.7	56.3	57.2
Do	90a	Sergeant major	do		do				57	42	95	75	17,504	5	3,501	57.7	62.0	60.1	60.6	60.8	60.7
Do	90b		do		do				57	34	76	59	17,504	5	3,501	66.5	71.1	74.9	58.1	71.7	75.1
Do	91a		do		do				57	50	57	50	17,504	5	3,501	62.2	65.0	67.0	60.2	60.2	60.3
Do	91b		do		do				76	50	76	42	17,504	5	3,501	51.8	61.1	66.4	61.6	66.6	68.1
Do	102a	First sergeant	do		do				57	42	57	34	8,142	4	2,036	66.4	69.3	69.1	67.0	71.4	72.0
Do	102b	do	do		do				57	59	57	59	8,142	4	2,036	61.6	69.4	69.1	66.1	69.0	73.5
Do	110	do	do		do				57	65	114	79	8,262	4	2,065	68.4	74.6	75.0	59.7	73.1	74.0
Do	111	do	do		do				76	75	76	81	7,227	4	1,807	64.4	74.3	70.9	64.2	71.1	78.9
Do	113	Ordnance sergeant	Ideal Arco	1-19-S	Steam	1.76	129	101	149	99	76	67	12,082	5	2,416	69.3	74.5	76.6	78.7	75.9	73.7
Do	114	Quartermaster sergeant.	Gurney	469	do	4.33	317	249	140	107	71	59	14,365	6	2,394	65.7	76.6	76.0	67.8	73.8	75.2
Do	30a	Civil engineer			do				205	168	95	75	11,446	5	289	65.5	67.0	67.3	65.3	54.5	66.7
Hospital	1		2 Brownells		do	36	3,154	2,462	4,190	3,830	171	176				67.3	70.3	70.0	69.7	69.0	67.1
Guard house	33		Return tubular	9	do				2,114	1,595	399	384	83,322	4	20,848	61.7	70.0	79.4	67.6	71.5	72.2
Post exchange and gymnasium.	47		Central heating plant, 5 Brownwell boilers, 100 horsepower each.																		
Mounted-gun platoon	48		do																		
Tower	49		do																		
Infantry barracks	59		do													67.4	70.6	65.1	67.9	67.5	67.2
Kitchens and mess	103		do	6742	do	[1] 120	10,512	8,208	13,236	11,651						69.7	70.9	70.6	68.1	69.6	78.8
Do	[2] 104		do																		
Do	105		do																		
Do	106		do																		
Do	107		do																		
Do	108		do																		
Commissary and quartermaster's storehouse	35		Ideal Premier	4927-313	do	3.83	280	221	1,009	732						56.6	78.0	78.8	54.1	73.9	74.9
Quartermaster's storehouse	85		Regular Dunning	3	do	4.28	313	246	411	369						67.9	72.4	70.3	64.8	70.5	71.7
Pumping station	29			266	Hot air	4.91	359	283	779	574						66.1	62.3	63.2	55.0	56.8	53.1
Cavalry barracks	81a	Troop C	Century	36	Steam	15.75	1,379	1,077	598	851	285	276	120,432	12	10,036	66.8	68.5	68.3	67.7	67.3	68.5
Do	81b	Troop D	do	36	do	15.75	1,379	1,077	934	781	304	267	120,432	12	10,036	61.4	68.1	71.5	63.7	68.3	70.1
Do	82a	Troop B	Ideal	3000	do	14.00	1,226	957	1,110	739	380	418	120,432	12	10,036	63.4	69.6	69.5	67.3	69.5	69.4
Do	82b	Troop A	do	3000	do	14.00	1,226	957	953	967	285	217	120,432	12	10,036	70.9	71.1	71.0	65.1	69.7	71.7

[1] Estimated.

[2] Grate area 24 feet each.

which give fairly accurate results if the heating apparatus is operated with the average degree of skill:

1. Allow 1 net ton of egg anthracite coal per room, equals 2,000 pounds.

2. Allow 1 pound of egg anthracite coal per 1 cubic foot of contents, equals 1,614 pounds.

3. Reduce the hot-water radiation to its equivalent steam radiation, which is 30 square feet, and allow that each square foot of direct steam radiation will condense 500 pounds of steam per square foot per season, and that the average heating boiler will evaporate 7 pounds of water per 1 pound of anthracite coal: $\frac{30\times500}{7}$ equals 2,143 pounds.

4. In the latitude of Washington, D. C., where the average winter temperature is 45° F., the coal consumed per square foot of grate surface in a heating boiler will average $1\frac{1}{2}$ pounds per hour for the 4,800 hours of the heating season, and the ratio of grate surface to direct hot-water radiating surface, averages 1 to 140: $\frac{50}{140}\times\frac{3}{2}\times\frac{4,800}{1}$ equals 2,570 pounds.

The average of all these rules is approximately 2,080 pounds.

The building herein considered is an average city residence, well protected by surrounding buildings. In a detached dwelling, similar to an officer's quarters, the allowance for the standard room previously assumed should be increased 10 per cent, or to approximately 2,240 pounds (a long ton) per annum to be safe.

In a climate where the winter temperature averages 35° F., the allowance should be increased an additional 15 per cent, or, in other words, for a variation of 10° F. on either side of the average winter temperature of 45° F., the coal consumption should be increased or decreased 15 per cent.

Respectfully,

(Signed) B. R. NEWTON,
Assistant Secretary.

TREASURY DEPARTMENT,
Washington, May 1, 1914.

The honorable the SECRETARY OF WAR,
Washington, D. C.

SIR: By direction of the Secretary, and referring to your letter dated April 10, 1914, in reference to the amount of fuel required for heating private residences, apartments, or other buildings, I have the honor to advise you that no special tests have been conducted by this department to ascertain the coal consumption in dwellings or apartments.

The data along this line, forwarded to you in department letter dated April 7, correspond with actual operating results obtained in various buildings under the control of this department and with the experience of public-service companies engaged in district heating.

Respectfully,

(Signed) B. R. Newton,
Assistant Secretary.

April 6, 1914.

To assistant and chief clerk:

In compliance with the request of the mechanical branch and your directions herewith, the following information is furnished as to the cost and kind of coal at various cities and posts. These figures do not represent the actual cost of the coal, but only the contract prices.

Portland, Me. (Fort Preble), chestnut, $7.95; stove and egg, $7.70.

Boston, Mass. (Fort Warren), bituminous, $5.77; stove and egg, $8.40.

New York City (Fort Hamilton), stove, $6.23; nut, $6.73; egg, $6.04.

Washington, D. C. (Fort Myer), egg, $6.45; stove, $6.80; nut, $7.

Fort Monroe, Va., nut, $6.17; stove, $5.92; broken, $5.27; egg, $5.85.

Wilmington, N. C. (Fort Caswell), bituminous, $6.95; nut, $11.10; stove and egg, $10.85.

Charleston, S. C. (Fort Moultrie), stove, $9.93; furnace, $9.68; nut, $10.17; bituminous, $6.50.

Tampa, Fla. (Fort Dade), bituminous, $8.25.

Chicago, Ill. (Fort Sheridan), bituminous, lump, $1.56 f. o. b. Johnson City, Ill.; egg and stove, $7 to $7.50 f. o. b. Chicago; chestnut, $7.25 to $7.75 f. o. b. Chicago.

St. Louis, Mo. (Jefferson Barracks), bituminous, lump, $2.71; anthracite, $7.55 to $8.34.

Atlanta, Ga. (Fort McPherson), nut, $9.07; stove, $8.82; bituminous, run of mine, $3.30; bituminous, lump, $3.57; egg, $8.71.

Little Rock, Ark. (Fort Roots), bituminous, run of mine, $4.25; lump, $5.88.

Mobile, Ala. (Fort Morgan), bituminous, run of mine, $4.80; lump, $5.85.

New Orleans, La. (Jackson Barracks), bituminous, lump, $5.75.

Galveston, Tex. (Fort Crockett), anthracite, $11; bituminous, lump, $7.50.

Oklahoma City, Okla. (Fort Reno), bituminous, lump, $5.48; bituminous, run of mine, $4.

Omaha, Nebr. (Fort Omaha), egg $6.95 to $7.51, chestnut $7.23 to $7.79, anthracite, f. o. b. Chicago; bituminous, lump, f. o. b. Johnson City, Ill., $1.70.

St. Paul, Minn. (Fort Snelling), bituminous, lump, $1.70 f. o. b. Johnson City, Ill.; anthracite, $7.44 to $7.61 f. o. b. Superior, Wis.

Bismarck, N. Dak. (Fort Lincoln), no contract.

Cheyenne, Wyo. (Fort D. A. Russell), bituminous, lump, $5.91.

Denver, Colo. (Fort Logan), bituminous, lump, $4.20 to $4.312; egg $7 to $7.50, chestnut $7.25 to $7.75, anthracite, f. o. b. Superior, Wis.

Bayard, Fort, N. Mex., bituminous, lump, $7.35 to $7.65; semi-anthracite, $12.40.

Helena, Mont. (Fort Keogh), bituminous, run of mine, $3.64; lump. $3.98, f. o. b. Duluth, Minn.

Salt Lake City, Utah (Fort Douglas), bituminous, $5.26.

Phoenix, Ariz. (Fort Huachuca), bituminous, lump, $9.46.

Seattle, Wash. (Fort Lawton), bituminous, lump, $9.25.

Portland, Oreg. (Vancouver Barracks), bituminous, lump, $3.65.

San Francisco, Cal. (Presidio), bituminous, lump, $10.

Rosecrans, Fort, Cal., bituminous, lump, $3.59 f. o. b. Gallup, N. Mex.

Egbert, Fort, Alaska, no contract.

St. Michael, Fort, Alaska, $24.50, bituminous.

Liscum, Fort, Alaska, bituminous, $15.30 and $13.25.

Gibbon, Fort, Alaska, no contract.

Honolulu, Hawaii, bituminous, lump, $7.75.

San Juan, P. R., bituminous, $5.73.

Manila, P. I., nut, $6.20; bituminous, $5.85.

Iloilo, P. I., bituminous, $6.90.

Zamboanga, P. I., bituminous, $7.60.

Cebu, P. I., bituminous, $6.90.

Camp E. S. Otis, Canal Zone, no contract.

H. L. ROGERS,
Colonel, Quartermaster Corps, United States Army.

City.	Kind of fuel.	Cost.
Mexico City	Current for heating, k. w. h	$0.10
	Gas, per 1,000 cubic feet	2.20
	Coal (Eureka, from West Virginia), per ton	22.00
	Charcoal, per ton	25.00
	Wood, per cord	30.00
Berne, Switzerland	Gas, per 3,531 cubic feet	4.44
	Hard wood, per cord, according to lengths	15.54–16.35
	Soft wood, per cord, according to lengths	13.84–14.65
	Coal, best anthracite, per 220 pounds	1.22
Habana, Cuba	Charcoal (universal fuel), per sack	2.00
Stockholm, Sweden	Hard coal, Yorkshire, per ton (2,000 pounds)	4.36
	Derbyshire (2,000 pounds)	4.09
	Scotch (2,000 pounds)	3.72
	Soft coal, Northumberland and Durham, per ton	4.09
	Wood, 125.668 cubic feet	8.87
Berlin, Germany	Coal, anthracite, per ton	12.30
	Pit, per ton	6.05
	Coke, per ton	6.05
	Wood, oak, per cord, unsplit	9.93
	Wood, oak, per cord, split	13.80
	Soft wood, per cord, unsplit	9.50
	Soft wood, per cord, split	13.38
Constantinople, Turkey	Coal, Cardiff, per ton	8.39
	Coal, Newcastle, per ton	9.30
	Coal, best Turkish, per ton	4.38
	Coal, inferior Turkish, per ton	3.77
Vienna, Austria	Coal, per ton (2,204 pounds)	7.60
	Wood, per ton (2,204 pounds)	11.38
	Wood, per cubic meter	3.66
Peking, China	Hard coal, Mexican, per ton	12.09
Brussels, Belgium	Coal, per ton, average	8.00
	Gas for heating and cooking, per cubic meter	.02
London, England	Coal, average cost per ton ..... shillings	30
Guatemala	State's houses are not heated here.	
St. Petersburg, Russia	Wood, $\frac{4.5}{100}$ of a cord ..... rubles	8
Santiago de Cuba	Wood, per cord	20.00
	Coal, per ton	12.00
	Gas (heating, per 1,000 cubic feet)	[1] 1.45
Tokyo, Japan	Wood, per cord	8.00
Monrovia, Liberia	Wood, per cord	3.00
Rio Janeiro	Coal, per ton	17.50
Paris, France	Soft coal, winter price, best quality	13.48
	Soft coal, winter price, cheapest quality	11.09
	Soft coal, summer price, best quality	12.43
	Soft coal, summer price, cheapest quality	10.78
	Hard coal, winter price, best quality	14.98
	Hard coal, winter price, cheapest quality	13.01
	Hard coal, summer price, best quality	14.27
	Hard coal, summer price, cheapest quality	12.03
	Hard wood, cut for fireplaces, winter price	9.71
	Hard wood, cut for fireplaces, summer price	8.93
Quito, Ecuador	Fuel, wood, per cord	6.00
Lima, Peru	Coal, per ton	14.00–15.00
Madrid, Spain	Wood, oak, per cord	27.60
	Coke, per sack (40 kilos)	.54
Rome, Italy	Hard wood, per cord	22.26
	Coke, per cord	9.00
	Fagots, per cord	20.81
	Anthracite, per cord	14.43
	Gas, per cord	5.57

[1] United States currency.

SCHEDULE OF ROOMS IN VARIOUS TYPES OF OFFICERS' QUARTERS.

COLONEL'S QUARTERS.

3–655. First floor, 1 reception hall, 4 rooms, 1 laundry, 1 toilet room; second fioor, 7 bedrooms, 3 bathroooms; attic floor, 3 servants' rooms, 1 servants' bathroom; total, 16 rooms, 4 bathrooms, and 1 toilet room.

95–C. Basement, 1 laundry; first floor, 4 rooms; second floor, 4 bedrooms, 1 bathroom, 1 sewing room; attic floor, 2 bedrooms, 1 servant's room, 1 servant's bathroom; total, 13 rooms and 3 bathrooms.

178. Basement, 1 laundry; first floor, 5 rooms, 2 servants' rooms, 1 servants' bathroom; second floor, 6 bedrooms, 2 bathrooms; total, 14 rooms and 3 bathrooms.

215. Basement, 1 laundry; first floor, 4 rooms; second floor, 4 bedrooms, 2 bathrooms, 1 servant's bathroom; attic floor, 3 bedrooms, 1 bathroom, 2 servants' bedrooms; total, 14 rooms and 4 bathrooms.

FIELD OFFICERS' QUARTERS.

145–F. Basement, 1 laundry; first floor, 4 rooms; second floor, 4 bedrooms, 1 bathroom, 1 servants' bathroom; attic floor, 2 servants' rooms; total, 11 rooms and 2 bathrooms.

243. Basement, 1 laundry; first floor, 4 rooms, 2 servants' rooms, 1 servants' bathroom; second floor, 6 bedrooms, 2 bathrooms; total, 13 rooms and 3 bathrooms.

235. Basement, 1 laundry; first floor, 4 rooms; second floor, 5 bedrooms, 2 bathrooms; attic floor, 2 servants' rooms, 1 servants' bathroom; total, 12 rooms and 3 bathrooms.

CAPTAINS' QUARTERS.

142–D. Basement, 1 laundry; first floor, 4 rooms; second floor, 4 bedrooms, 1 bathroom; attic floor, 2 servants' rooms, 1 servant's bathroom; total, 11 rooms and 2 bathrooms.

163–B. First floor, 4 rooms, 1 servant's room, 1 servant's bathroom; second floor, 5 bedrooms, 1 bathroom; total, 10 rooms and 2 bathrooms.

236. Captain's quarters, basement, 1 laundry; first floor, 3 rooms; second floor, 4 bedrooms, 1 bathroom; attic floor, 1 servant's room, 1 servant's bathroom; total, 9 rooms and 2 bathrooms.

LIEUTENANTS' QUARTERS.

256–A. Basement, 1 laundry; first floor, 3 rooms, 1 servant's room; 1 servant's bathroom; second floor, 3 bedrooms, 1 bathroom; total, 8 rooms and 2 bathrooms.

120–H. Basement, 1 laundry; first floor, 3 rooms; second floor, 3 bedrooms, 1 bathroom; attic floor, 2 servants' rooms, 1 servants' bathroom; total, 9 rooms and 2 bathrooms.

260. Basement, 1 laundry, 1 servant's bathroom; first floor, 3 rooms; second floor, 3 bedrooms, 1 bathroom, 1 servants' room; total, 8 rooms and 2 bathrooms.

COMMENTS OF POST AUTHORITIES RELATIVE TO FUEL TESTS AT FORT MYER, VA., WASHINGTON BARRACKS, D. C., AND FORT SHERIDAN, ILL.

The following reports give the remarks and recommendations of the post authorities relative to the methods employed and results obtained at the fuel tests at the posts above named.

FORT MYER, VA., *April 4, 1914.*

Q. M. O.—1469.
From: Quartermaster.
To: Chief, Quartermaster Corps.
Subject: Fuel tests.

1. In compliance with letter of January 31, 1914 (No. 491125), the scheme of the tests was carefully gone over, enlisted men were detailed as firemen and made familiar with the instructions, and the general scheme outlined in paragraph 4 was carried out.

2. Second Lieut. Homer M. Groninger, Fifth Cavalry, assistant to the quartermaster, was given immediate charge of the operations of the test. Sergeants Firemen Allen, Condon, and Conroy, Quartermaster Corps, sent here for the purpose, were given charge of districts approximating one-third of the garrison to each.

3. The furnaces were overhauled, drafts regulated where necessary, minor repairs made, and the furnaces generally put in good condition.

4. The 17 enlisted men acting as firemen were carefully instructed in the method of firing laid down in the instructions, and each fireman was given a copy of these instructions.

5. Thermometers were installed in each building with a furnace and galvanized-iron ash cans to be used as coal measures issued.

6. Copies of instructions to officers of the post, dated February 9 and February 26, have already been submitted with other data; also copy of instructions to the district firemen of February 12.

7. The test for furnace boilers began February 15 and for fuel for cooking February 18. All ended March 25.

8. Temperatures were read in each house three times daily at approximately 7 a. m., 11 a. m., and 7 p. m.

9. The method of determining the weight of coal used daily was to weigh a can full of each kind of coal, and, with this weight as a basis, coal for furnaces, cook stove, laundry, and fireplace was placed in

separate piles and places. A little more than a sufficient quantity was measured out for each day and on the following morning the remainder was put back in the can and weighed by use of a measuring stick.

10. Capt. Frank T. Hines, Quartermaster Corps, in charge of the tests, made several visits to the post, explained the object of the test to all officers assembled, and explained more fully the instructions received as to the details of the test. Mr. Anderson and Mr. Tripp, engineers, from the office of the Chief of the Quartermaster Corps, made periodical visits to the post, examined the records, and, as Capt. Hines's representatives, approved methods used or suggested changes, which were in all instances carried out.

11. The weather conditions during the test were quite varied, ranging from a warm day when the temperature at 8 a. m. was 50° to a temperature of 3° at 8 a. m. on another day. There were several storms during the period, one a blizzard, on the night of March 1–2, with a high wind, breaking many windows and freezing many pipes thus exposed. The minimum temperature on this day was 15°.

12. Under instructions transmitted by Mr. Tripp, all original records were removed by him to the War Department on March 26; all data relative to the test is therefore in the office of the Chief of the Quartermaster Corps, no retained copies being on file at this post. Daily notes relative to the test made by Lieut. Groninger were also submitted with the above data.

13. Since the conclusion of a previous test about two years ago, the firing of all heating boilers at this post has been under the direct control of a civil employee of the Quartermaster Corps, the actual firing being done, with few exceptions, by enlisted men detailed for the purpose. Each organization furnished a man for its boiler and hot-water heater, and in officers' quarters one man managed approximately five fires. All firemen have been instructed in their duties and their work is under the daily supervision of the employee above mentioned. The system has worked satisfactorily and, it is thought, economically, although there are no definite figures at hand for comparison.

The above is mentioned as it is noted that a similar scheme is recommended for adoption in a proposed circular accompanying other papers transmitted for use during this test.

14. No opinion on the general method of determining coal allowances can be given until the tabulation of data now going on in the office of the Chief of the Quartermaster Corps is completed.

W. J. Glasgow,
Captain, Quartermaster Corps.

OFFICE OF THE QUARTERMASTER,
Washington Barracks, D. C., April 7, 1914.

From: Assistant quartermaster.
To: The quartermaster, Washington Barracks, D. C.
Subject: Fuel test.

1. In compliance with your instructions I submit the following remarks with reference to the recent heating test conducted at this post. All data collected has been turned over to the Chief, Quartermaster Corps.

2. In conducting the work, all the plants were fired by the men regularly employed at that work, i. e., by Quartermaster Corps men or special-duty men in the public buildings and by the officers' servants in their quarters.

3. In connection with the method of issuing fuel as outlined in the memorandum from the office of the Chief of the Quartermaster Corps, it is essentially the same as the method regularly followed on this post. However, it would appear from the memorandum that it contemplates having a noncommissioned officer on this work. It is thought that this should be done. While it is difficult to point to any definite saving that would result to the Government by placing a noncommissioned officer on a job that is now filled by a private, it is thought that the advisability of this is apparent from the importance of the work and the responsibility placed on this man. Noncommissioned officers selected for these positions should have general supervision over all heating plants on the post, making all necessary minor repairs and keeping the plants clean and in adjustment.

4. Considering the 12 sets of so-called captains' quarters, an examination of the results of the test will show that their daily consumption of coal varied considerably, although they were maintained at approximately the same temperature. As these houses are all identically the same size and of the same construction throughout, it would appear that the differences in coal consumption were due principally to the differences in the care exercised in firing. It is thought that a competent fireman of the Quartermaster Corps should be detailed to attend to all these fires, and that with such a fireman the coal consumption in all the houses could be reduced to a point at least as low as the consumption in that house now using the least coal, and that the price of the coal thus saved would be considerably more than the wages of the fireman.

5. The method suggested for fixing a definite allowance of fuel for cooking and washing for each company would have the advantage of reducing the paper work in this office. However, it does not appear that this would effect any reduction in the consumption of coal for these purposes.

6. It is thought that the greatest waste of coal at this post is due to the following causes:

(*a*) In the heating plants, due to inefficient firemen. Formerly these plants were fired by enlisted men detailed from the organizations on extra duty who received extra-duty pay. At the present time the firing is done in part by enlisted men of the Quartermaster Corps and in part by soldiers detailed on special duty without any additional compensation. Competent men for this work can not be obtained by detailing soldiers from the companies on special duty. It is thought that the saving effected by abolishing extra-duty pay for the men detailed in the boiler rooms will be more than overcome by the increased cost of fuel and repairs under the present system of using privates of the Quartermaster Corps and men on special duty. It is thought that a saving could be made by providing a sufficient number of competent firemen in the post allotment of Quartermaster Corps men, whose pay should be sufficiently high to obtain the proper class of men.

(*b*) In the officers' quarters, due to inefficient firing by their servants. It is thought that this could be remedied by allotting a competent fireman of the Quartermaster Corps to care for these fires.

L. C. HERKNESS,
First Lieutenant, Corps of Engineers.

[First indorsement.]

411.] QUARTERMASTER'S OFFICE,
WASHINGTON BARRACKS, D. C., *April 8, 1914.*

To CHIEF, QUARTERMASTER CORPS, UNITED STATES ARMY:

1. Forwarded. Lieut. Herkness, Corps of Engineers, assistant quartermaster, had actual charge of the experiments carried out in heating test, under charge of your office. The tests were carried out as directed. His remarks are concurred in.

L. W. JORDON, Jr.,
Captain, Quartermaster Corps, Quartermaster.

Tests at this post were supervised by Mr. P. M. Anderson, electrical and mechanical engineer of this office. In reference to the report of the quartermaster, Mr. Anderson states as follows:

I have personally supervised the test at this post and concur in the statement that the firing was done in the usual manner and that the Quartermaster Corps sergeants merely supervised the work at this post. However, these supervising sergeants insisted that all equipment be kept clean and in good working order and that the fires were cared for in the proper manner. This no doubt resulted in a considerable saving in the consumption of coal.

I believe that the law providing fuel for officers contemplated that a sufficient quantity of fuel should be furnished to properly heat the quarters occupied by that officer if the fuel was properly handled. On examining the heating plants at this post before the test was started, it was very apparent that proper precautions were not

being taken by the officers in the consumption of fuel. At Washington Barracks only two of the automatic regulators were found in operative condition and practically all fires were controlled by drafts through the firing door instead of by drafts through the ashpit and smoke flue. In one furnace, especially, soot had collected to a depth of not less than 3 inches, showing that the flues had not been cleaned for years.

I do not concur in the assistant quartermaster's recommendation that firemen be allotted from the Quartermaster Corps with pay sufficiently high to obtain the proper firing of the boilers. I believe the Government contemplated that a proper amount of fuel should be furnished, but I do not believe that it is contemplated to furnish the officers with highly paid men to supervise the firing of such fuel. I see no reason why each officer should not, to a certain extent, supervise the firing of his own quarters, so as to prevent any such conditions as were observed at this post. I believe that rigid instructions should be issued to all officers as to the method of firing fuel, and that officers should either do their own firing or provide their own men for doing same. The only men which I recommend that the Government furnish in connection with fuel consumption would be merely one or two men at each post detailed to supervise the heating equipment and see that the instructions issued are properly carried out.

OFFICE OF THE QUARTERMASTER,
Fort Sheridan, Ill., March 26, 1914.

From: Quartermaster.
To: Commanding officer.
Subject: Fuel tests.

1. Complying with your instructions of February 14, I inclose herewith reports relative to the use of fuel in certain quarters in this post, together with the surgeon's report of temperature. The test commenced February 18.

2. Careful instruction was imparted to all men in charge of furnaces, and everything possible was done to obtain an accurate account of the coal consumed.

3. The question as to the amount of coal to be allowed an officer or noncommissioned officer at this post is a very hard one to determine, as it depends upon the kind of quarters he occupies; a second lieutenant, for instance, occupying a suite in the club building not requiring as much fuel (provided all or the majority of suites are occupied) as another occupying one side of a double set of lieutenants' quarters, and this officer will not require as much as another of the same grade occupying a single set of lieutenants' quarters.

4. The amount of fuel used in any particular barracks or set of quarters depends not only upon the temperature but upon the velocity of the wind as well; thus with a fairly strong wind, such as we often have here, from 20° to a temperature of 25°, the exposed side of a double barrack or double set of quarters will require a very much greater amount of fuel than the protected side. Besides this, there is the question of hygiene. Some people keep the house pretty well closed during cold weather; others—in fact, the majority—keep a number of windows more or less open in order to secure a circulation

of fresh air and to maintain a proper temperature. This requires a greater consumption of fuel by those following this method.

5. In many cases the fuel used for cooking purposes is also used for heating kitchens and pantries.

6. It will be observed that the central heating plant was kept in operation during the winter. This was done to heat the exchange and gymnasium, the riding hall, headquarters, and the barracks occupied by the mounted guard platoon and the detachment of the Quartermaster Corps. This required nearly as much fuel as would have been required to heat all of the buildings pertaining to that system.

F. H. SARGENT,
Major, Quartermaster Corps.

[First indorsement.]

DR 9–A

Headquarters, Fort Sheridan, Ill., March 30, 1914. To the commanding general, central department, Chicago, Ill.

T. B. TAYLOR,
Captain, Fifth Cavalry, Commanding.

[Second indorsement.]

No. 25103 Hz–TO.

Headquarters, Central Department, Office Department Quartermaster, April 2, 1914. To Chief, Quartermaster Corps. Reference O.C.Q.M.C. 491125, January 24, 1914.

D. E. MCCARTHY,
Colonel, Quartermaster Corps.

22 incls.

CORRESPONDENCE RELATIVE TO DATA, ARMY AND NAVY CLUB, WASHINGTON, D. C.

THE ARMY AND NAVY CLUB,
Washington, D. C., February 18, 1914.

Capt. FRANK T. HINES, United States Army,
War Department, Washington, D. C.

MY DEAR CAPTAIN: I thought it would be safer to go to the architects and builders to get official figures upon the subject of the cubical contents of the club and the other information, and have to inform you that the average bedroom cubical space is 1,750 cubic feet. This is without bathrooms or halls. The average cubical space of a bathroom is 595 cubic feet. The total cubical contents of the entire building are 959,595 cubic feet. This includes everything, basement, halls, etc.

Of course, in making your estimate, you would consider the fact that the bedrooms are heated practically for the entire 24 hours, while the other spaces, such as lounging rooms, reception rooms, hallways, dining rooms, music rooms, parlors, card rooms, grillroom, billiard room, storerooms, and all of the basement space are not heated except when necessary; the heat being turned off as a matter of routine as early in the evening as possible, or, at the latest, 1 a. m., when the club closes.

The cost of heating the club for the period January 1, 1913, to December 31, 1913, was $2,476.62. The cost of the heating plant, including the boilers, as furnished by Mr. Wagner, the contractor, was $18,428.10. The cost of repairs to the heating plant for the year has been $61. This seems very small, but of course, it is on account of the plant being practically new.

Respectfully,

F. L. SANDOZ, *Manager.*

THE ARMY AND NAVY CLUB,
Washington, D. C., February 20, 1914.

Capt. FRANK T. HINES,
War Department, Washington, D. C.

MY DEAR CAPTAIN: I have the honor to acknowledge the receipt of your letter, dated February 19, calling attention to certain infor-

mation about the heating of the club which my previous letter did not contain, and in reply to your letter have to state that we employ—

	Salary.	Meals.	Total.
	Per month.		*Per month.*
1 chief engineer	$100.00	$40.50	$140.50
1 night engineer	50.00	40.50	90.50
1 fireman	30.00	21.50	51.50
Total	180.00	101.50	282.50

Besides furnishing heat, strictly speaking, for heating the club, the boilers are also used to furnish hot water throughout the club, for washing, bathing, etc., and also to furnish steam to the kitchen at a low pressure of about 25 pounds, which steam is used for boiling vegetables, making coffee, and for heating dishes, etc.

These are all the uses that we have for the boilers, as all the motive power in the club is generated by electricity, which we purchase from the city electric company.

For the year 1913 one boiler has been in use all of the time. Two boilers had to be used from February 10 to 20, 1913, and this was the only time when we were compelled to use two boilers, as the winter, you will remember, was a very mild one.

Steam was used for heating purposes from January 1, 1913, to about May 15, 1913, when it was turned off for the summer. Our records do not show clearly the exact dates, but there were some days when steam was turned on again for such time as the weather was too cool for comfort, but from the data and the recollection of the chief engineer and his assistants, it is probably safe to assume that it was practically turned off about May 15. Steam was again turned on for the cold weather on October 19, 1913, and remained on during the remainder of the year, to December 31, 1913.

If there is any information which has been omitted, please let us know and we shall be glad to supply it.

Very truly, yours,

F. L. SANDOZ, *Manager.*

THE ARMY AND NAVY CLUB,
Washington, D. C., March 9, 1914.

Capt. FRANK T. HINES, United States Army,
Office Chief of Quartermaster Corps, Washington, D. C.

DEAR SIR: Answering your letter of March 6, I have the honor to state that the cost of the coal used for generating steam for cooking purposes in the kitchen and for heating the water used for members' bathing and washing purposes during the summer months only—that is, during the months when heat was not turned on the rooms gen-

erally throughout the club—was $534.80. During these months the cost of coals only for cooking in the kitchen was $258.90. In addition to this cost we also used about $150 worth of gas for lighter cooking purposes, such as toasting bread, light broiling, etc., so that for these summer months our fuel for kitchen use amounted to altogether about $408.90.

I am giving you this detailed information, as I suppose it may help you to form an estimate in proportioning the part of the cost of fuel in the fireroom, which, as previously stated, was $534.80, between the kitchen and the rooms. In other words, as it is impossible to state definitely how much coal is required for generating the steam which is used in the kitchen for boiling potatoes and vegetables and making coffee, and how much is used for bathing and washing by the members, with this detailed information you may be able to judge yourself how it should be divided.

If there is any other information we can supply, we shall be glad to do so.

Very respectfully,

F. L. Sandoz, *Manager.*

GENERAL INSTRUCTIONS ISSUED AT FORT MYER, VA., WITH A VIEW TO CARRYING INTO EFFECT THE FUEL TESTS DIRECTED BY THE CHIEF OF THE QUARTERMASTER CORPS, AND NOTES THEREON.

Memorandum. FORT MYER, VA., *February 9, 1914.*

Under instructions from the Chief of the Quartermaster Corps a coal test will be conducted at this post, commencing the 10th instant.

In order that proper data may be obtained in this connection, the following instructions are published:

All fires pertaining to heating apparatus on the post will be under the charge of Second Lieut. H. M. Groninger, Fifth Cavalry, assistant to the quartermaster.

Boilers will be fired only by the regularly detailed firemen, and none of the boiler adjustments will be altered except by these firemen. Under no circumstances will occupants of the quarters or servants interfere in any way with fires or adjustments of boilers. All firemen, including those in the troop and battery quarters, will be under the direction of Second Lieut. H. M. Groninger, Fifth Cavalry, assistant to the quartermaster, who has been charged with the supervision of this test. Troop and battery firemen will report to Lieut. Groninger for instructions at the quartermaster's office at 9 a. m. February 10, 1914.

The proper operation of the air valves is of great importance. In case the room is not properly heated the trouble is often due to faulty operation of the air valves on the radiators. These can be adjusted by the occupants of the rooms. Some air valves permit of adjustment by removing a cap at the top of the air valve and slightly opening or closing valve by means of a key or screw driver. The following rules should be observed in making the adjustment of any valve:

Never attempt to adjust them except when there is at least 1 pound steam pressure on the system. The pressure gauge will always register at least 1 pound between 7 a. m. and 7 p. m. Then, if the radiator does not heat properly, remove cap from air valve and slack off screw or nut at top of valve until air blows through freely. Allow this action to continue until radiator is hot throughout and steam appears at the air valve; then tighten valve just enough to stop all leakage of steam, and replace cap. Do not remove air valve from radiator. If valve leaks steam or water, tighten just enough to stop leak.

Officers will familiarize themselves as to the barracks of their fireman. In case of dissatisfaction they will telephone him and have their fire reduced or increased.

By order of Col. Wilder:

EDWARD T. DONNELLY,
Captain and Battalion Adjutant, Third Field Artillery,
Adjutant.

WAR DEPARTMENT,
OFFICE OF THE QUARTERMASTER,
Fort Myer, Va., February 10, 1914.

The following assignment of boilers will take effect this date:

Sergt. Condon, in charge.

Quartermaster's office, Conley (prisoner).

Officers' club, Fletcher (Battery D).

Maj. Fleming, Lieut. Sheridan, Lieut. Olmstead, Chaplain Houlihan, Capt. Elliot, Lieut. Milliken—Matthias (Battery D).

Col. Wilder, Maj. Summerall, Capt. Austin, Capt. Day, Capt. Donnelly—Coyle (Troop L).

Lieut. Simpson, Lieut. Baird, Lieut. Stewart, Dr. Griffin, Lieut. Hillman—Stewart (Battery F).

Lieut. Downer, Lieut. Carter, Lieut. Burleson, Lieut. Morrison, Capt. Sturges—Schultz (Troop I).

Capt. Connell, Capt. Glasgow, Dr. McMillan, Capt. Forsyth, Capt. Locke—Reyhok (Battery E).

Capt. Williard, Capt. Gallup, Maj. Allen—Bainter (Troop I).

Sergt. Allen, in charge.

Troop K quarters, Pvt. Reisch; Troop I quarters, Pvt. Fox; Troop M quarters, Pvt. Wiseman; Troop L quarters, Pvt. Van Camp; Battery D quarters, Pvt. Plunkett; Battery E quarters, Pvt. Butean; Battery F quarters, Pvt. Peck; hospital, Pvt. Patterson; headquarters, band, and guardhouse, Prisoner Tibbs; post exchange, Pvt. O'Toole.

———— ————,
Second Lieutenant, Fifth Cavalry, Assistant Quartermaster.

QUARTERMASTER'S OFFICE,
Fort Myer, Va., February 12, 1914.

INSTRUCTIONS FOR DISTRICT FIREMEN

This post is divided into three districts for the purpose of conducting the coal test directed by the Chief of the Quartermaster Corps.

The first district will include all boilers and fires beginning at the quartermaster's office and extending to quarters No. 12. This

includes commissary buildings, noncommissioned officers' line, officers' mess, and officers' quarters to and including quarters No. 12.

The second district begins at quarters No. 3 and extends along officers' line. This district also includes headquarters, band, guardhouse, post exchange, and hospital.

The third district comprises boilers in all barracks and all fires pertaining to barracks and stables.

The firemen in charge of these districts are responsible that the men under them are conversant with the instructions given by the Chief of the Quartermaster Corps relative to the firing of boilers and heaters. A copy of these instructions has been read to these men and they each have a copy in their possession. The district firemen will adjust these boilers as far as possible and submit a list of repairs that are absolutely necessary. They will be responsible that the instructions given on back of temperature record are carefully and faithfully carried out in their districts. They will report at this office until further orders between 9 a. m. and 10 a. m. daily except Sunday.

———— ————,
Second Lieutenant, Fifth Cavalry, Assistant Quartermaster.

FORT MYER, VA., *February 26, 1914.*

Memorandum for all officers.

In each set of officers' quarters a certain amount of stove coal will be measured daily and piled on the cellar floor. Sacks of coal have been placed in each laundry room for use in laundry stoves. Certain sacks have been set aside in the cellar hallway for use in fireplaces. Officers should exercise the greatest care to instruct their servants so that these servants will obtain their coal from the proper places.

Neither officers nor servants will under any circumstances make any adjustments on the boilers. If the quarters are not comfortable the fireman will be so notified. In case the fireman can not be found, a written complaint will be attached to the thermometer. The thermometers are read by the sergeant fireman at about 7 a. m., 11 a. m., and 7 p. m.

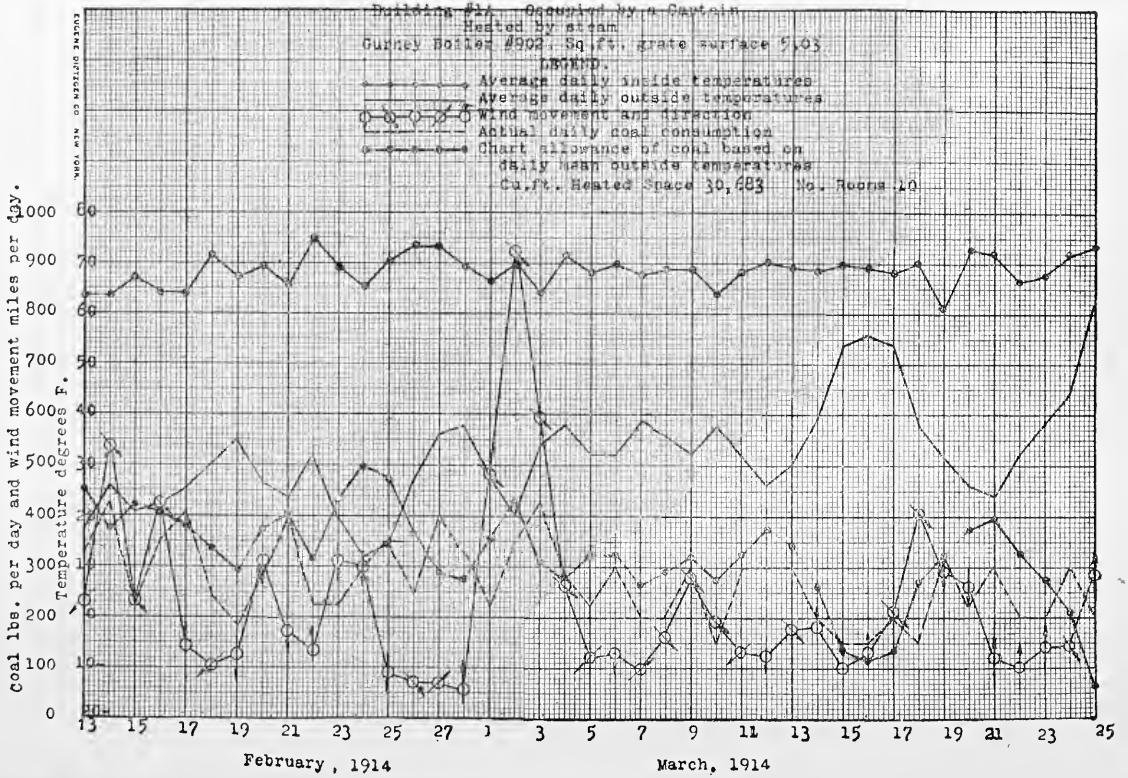
W. J. GLASGOW,
Captain, Quartermaster Corps, Quartermaster.

Approved:
By order of Col. Wilder.
EDWARD T. DONNELLY,
Captain and Battalion Adjutant,
Third Field Artillery, Adjutant.

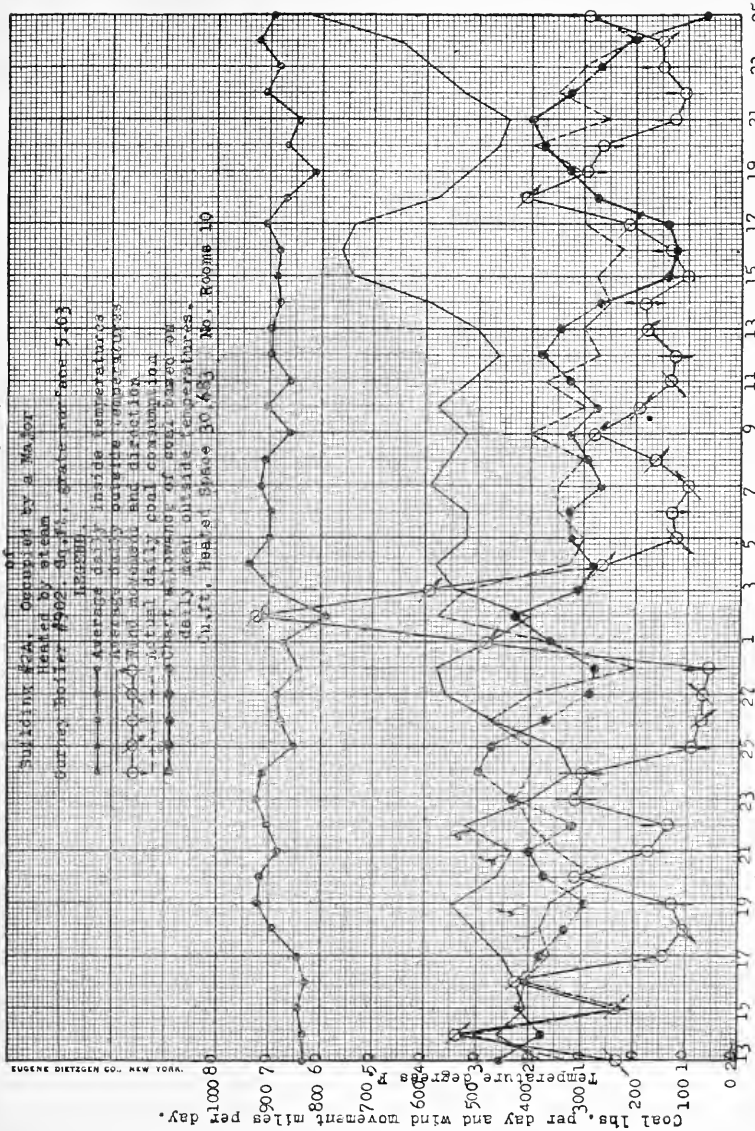
Daily record of temperatures and coal consumption
at
Washington Barracks, Washington, D.C.
of

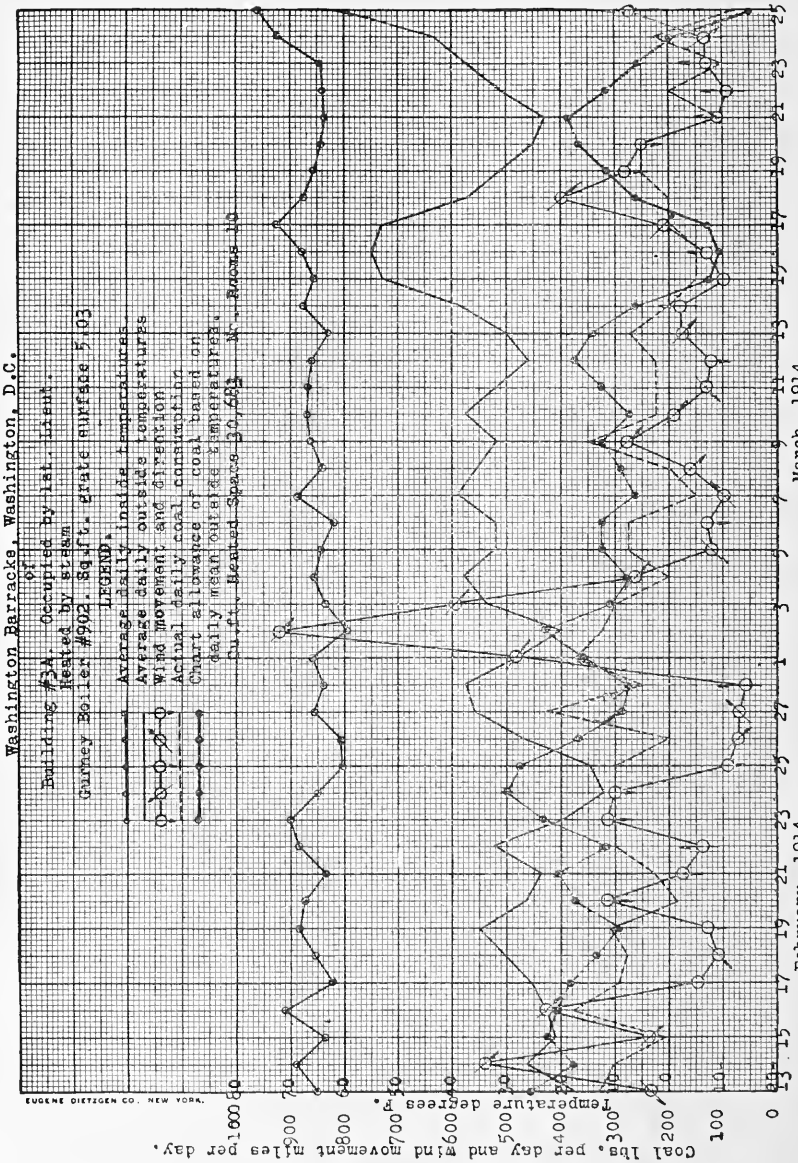
Building #14. Occupied by a Captain.
Heated by steam
Gurney Boiler #902. Sq. ft. grate surface 7.05

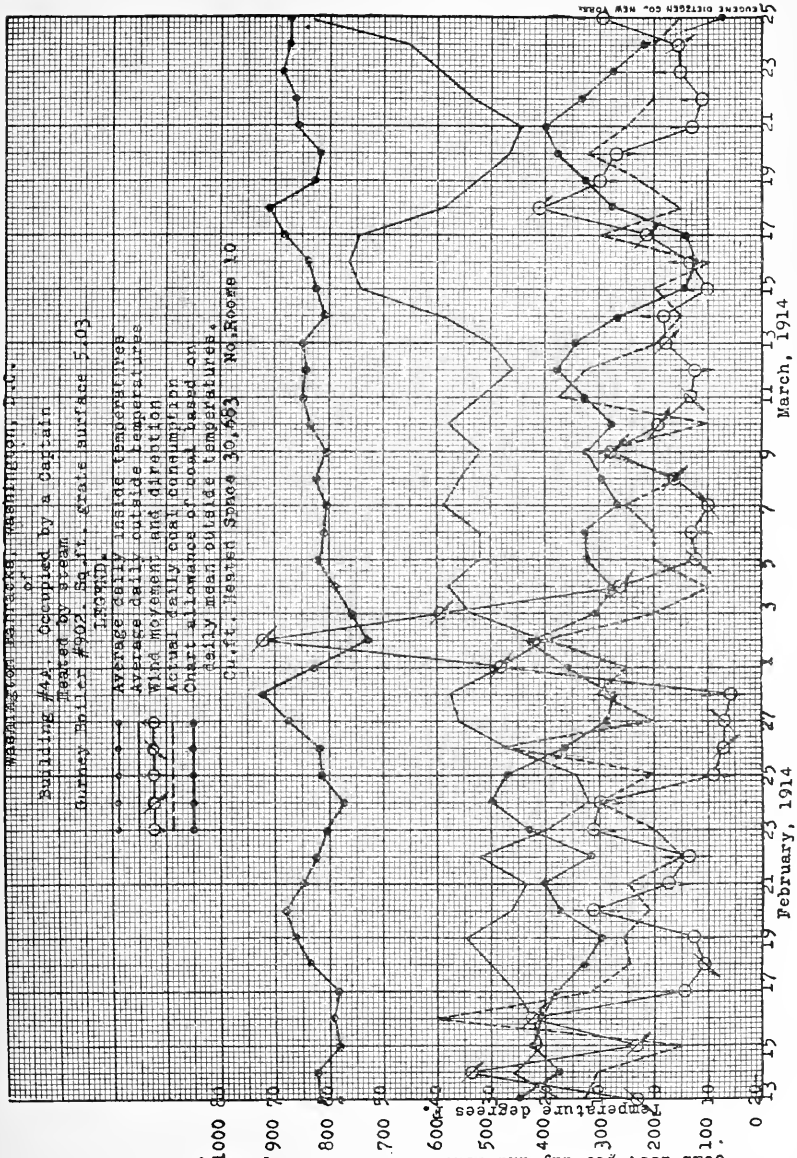
LEGEND.
Average daily inside temperatures
Average daily outside temperatures
Wind movement and direction
Actual daily coal consumption
Chart allowance of coal based on daily mean outside temperatures
Cu.ft. Heated Space 30,683 No. Rooms 10



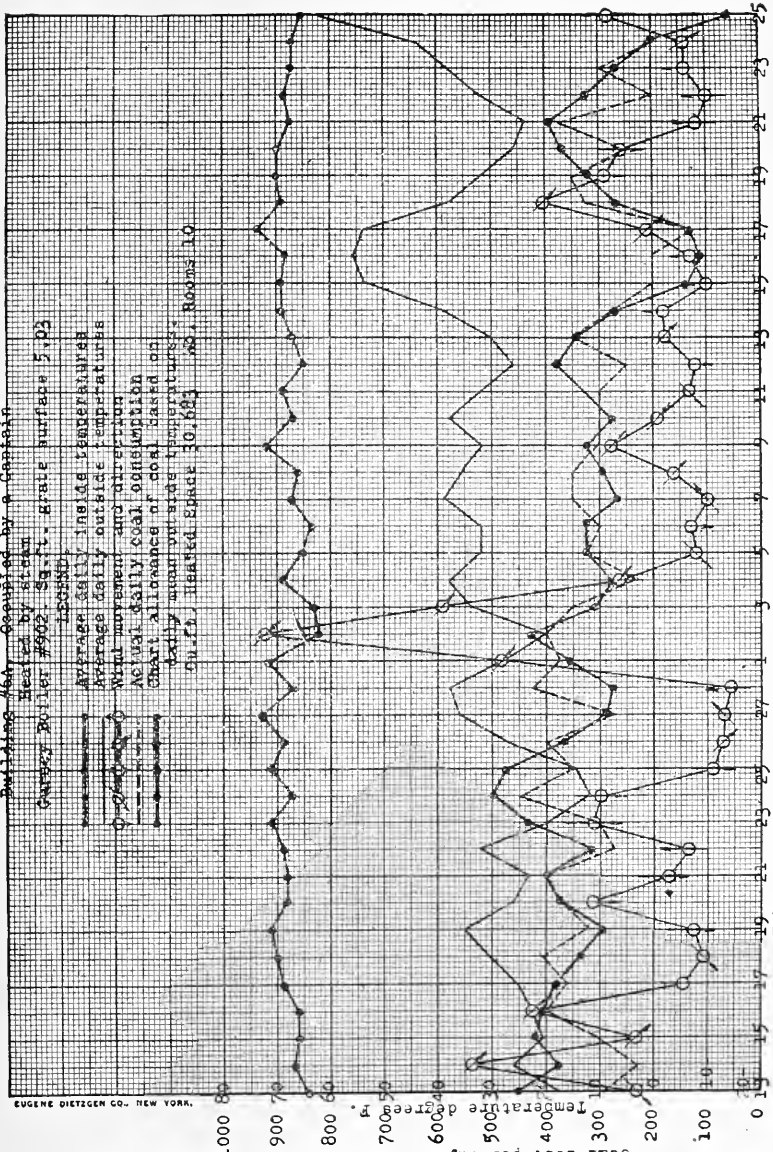
Daily record of temperatures and coal consumption at Washington Barracks, Washington, D.C.




Daily record of temperatures and coal consumption
at
Washington Barracks, Washington, D.C.
Building #34 occupied by Lt. Hunt.
Heated by steam
Gurney Boiler #902. Sq.ft. grate surface 5.03
LEGEND.
Average daily inside temperatures
Average daily outside temperatures
Wind movement and direction
Actual daily coal consumption
Chart allowance of coal based on
daily mean outside temperatures.
Cu.ft. Heated Space 30,561 M. Rooms 10
EUGENE DIETZGEN CO. NEW YORK.
Coal lbs. per day and wind movement miles per day.
Temperature degrees F.
February, 1914
March, 1914

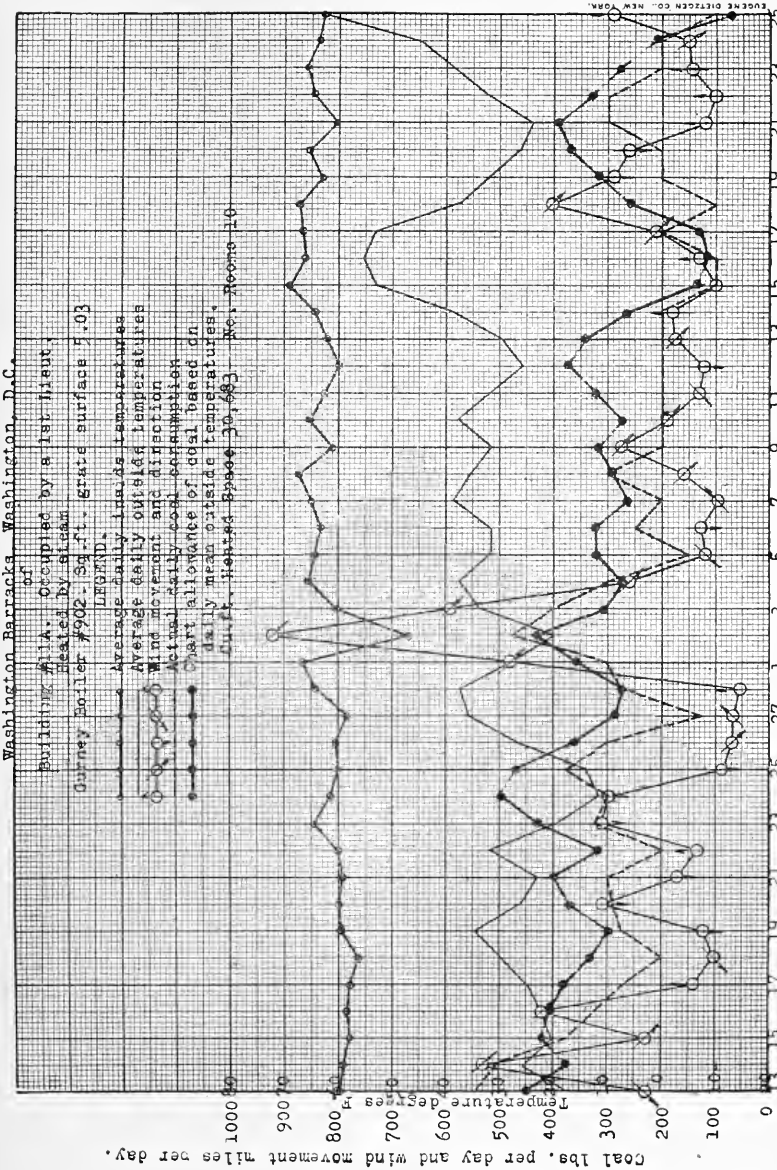

Daily record of temperatures and coal consumption
at
Washington Barracks, Washington, D.C.
Building #42. Occupied by a Captain
Heated by steam
Gurney Boiler #902. Sq.ft. grate surface 5.03
LEGEND.
Average daily inside temperatures
Average daily outside temperatures
Wind movement and direction
Actual daily coal consumption
Chart allowance of coal based on
daily mean outside temperatures.
Cu.ft. heated space 30,963 No.Rooms 10
Coal lbs. per day and wind movement miles per day.
Temperature degrees
February, 1914
March, 1914
EQUITABLE DISTRICT CO. NEW YORK.

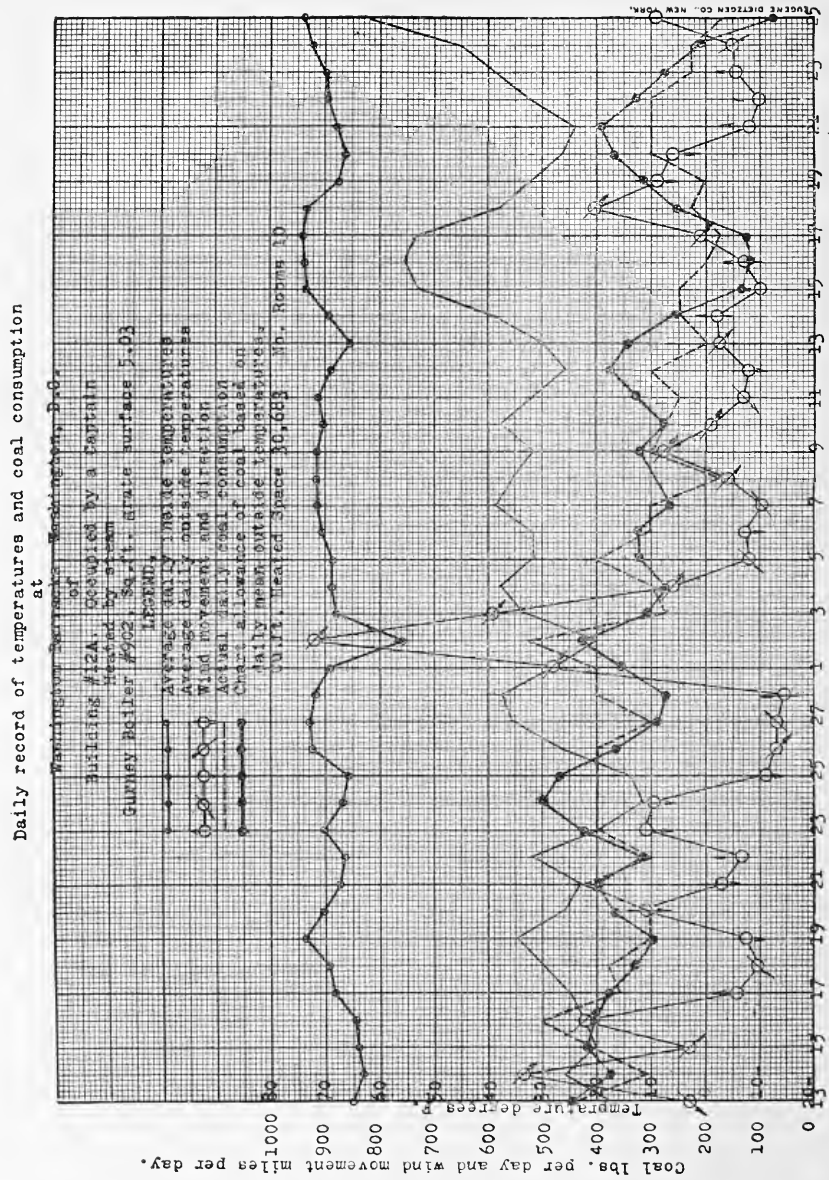
Daily record of temperatures and coal consumption
at
Washington Barracks, Washington, D.C.
Builders Iron Co., Orenipe Hyde Captain
Heated by steam
Gurney Boiler #900 Sq.ft. Grate surface 5.02
LEGEND
Average daily inside temperatures
Average daily outside temperatures
Wind movement and direction
Actual daily coal consumption
Chart allowance of coal based on
daily mean outside temperature.
Ou.Ft. Heated Space 30,663 No. Rooms 16
EUGENE DIETZGEN CO. NEW YORK.
Coal lbs. per day and wind movement miles per day.
Temperature degrees F.
February, 1914
March, 1914

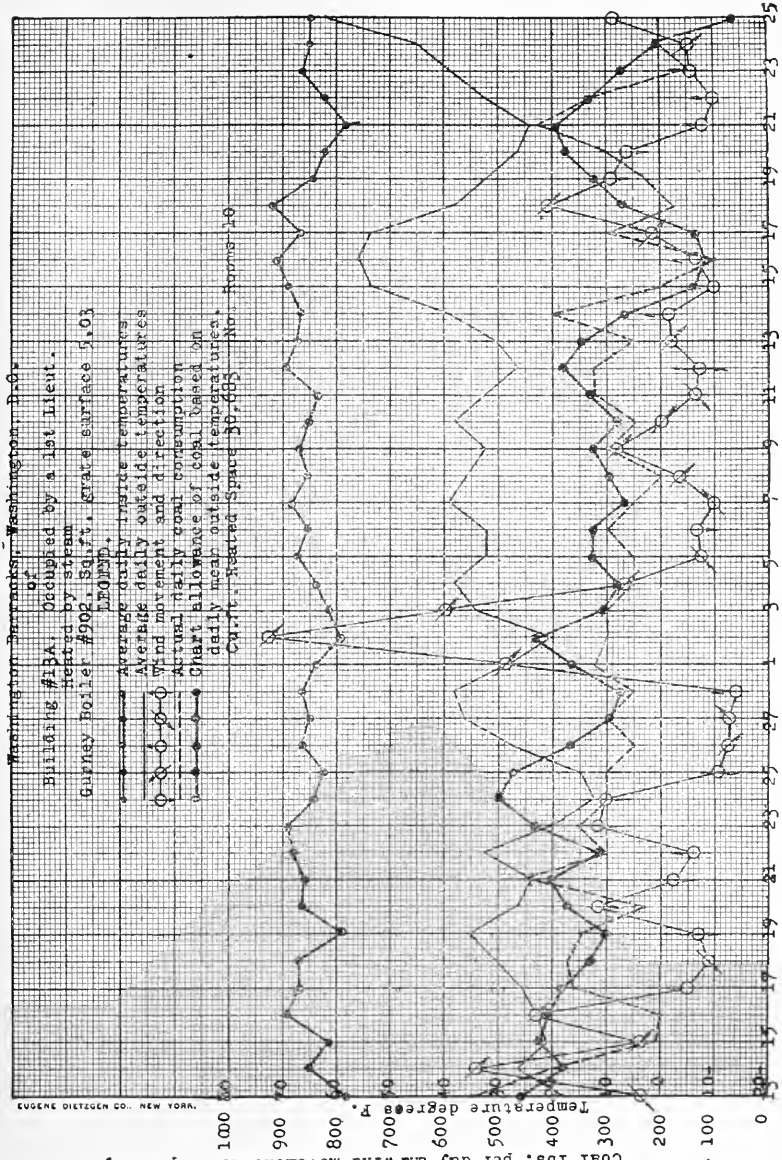

Daily record of temperatures and coal consumption
at
Washington Barracks, Washington, D.C.
Buildings #64, Occupied by a Captain
Heated by steam
Carey Boiler #902 39 s.f. grate surface 5.03
LEGEND
Average daily inside temperatures
Average daily outside temperatures
Wind movement and direction
Actual daily coal consumption
Chart allowance of coal based on
Daily mean outside temperatures
Cu.ft. Heated Space 30,665 No. Rooms 10
EUGENE DIETZGEN CO. NEW YORK.
Coal lbs. per day and wind movement miles per day.
Temperature degrees F.
February, 1914
March, 1914

Daily record of temperatures and coal consumption at Washington Barracks, Washington, D.C.

Daily record of temperatures and coal consumption
at
Washington Barracks, Washington, D.C.
of
Building #14. Occupied by 4 Bat Lieut.
Heated by steam
Gurney Boiler #902. 3g.ft. grate surface F.03

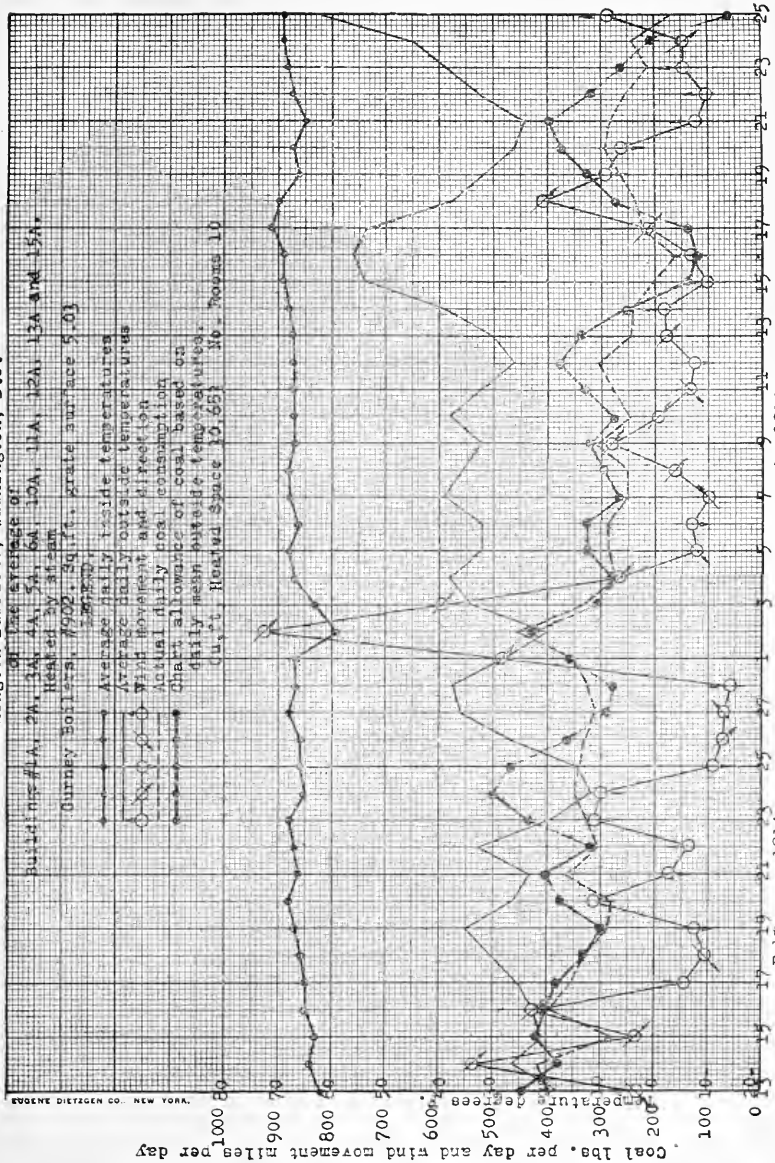


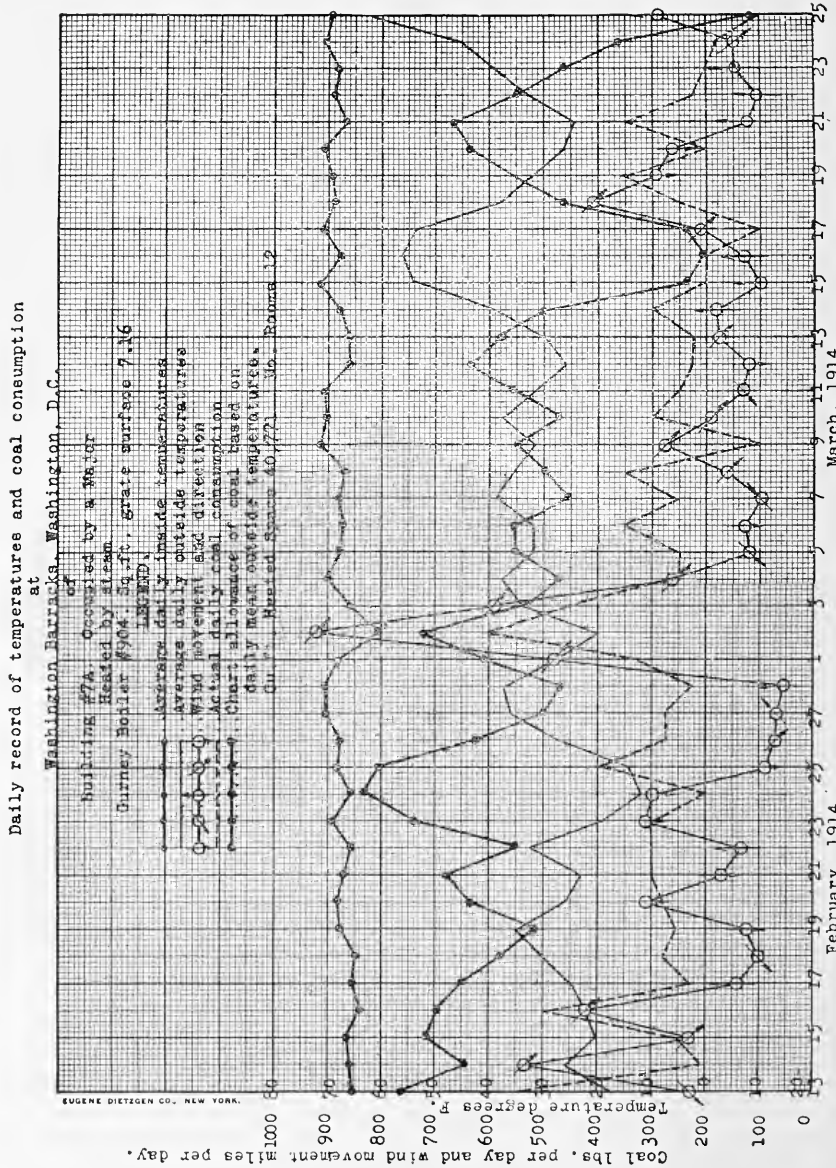

Daily record of temperatures and coal consumption
at
Washington Barracks, Washington, D.C.
Building #12A.
Heated by a Certain
Gurney Boiler #602, Sq.ft. grate surface 5.03
Legend.
Average daily inside temperatures
Average daily outside temperatures
Wind movement and direction
Actual daily coal consumption
Chart allowance of coal based on
daily mean outside temperatures
Cu.Ft. Heated Space 80,688 Mn. Rooms 10
Coal lbs. per day and wind movement miles per day.
Temperature degrees F.
February, 1914
March, 1914
EUGENE DIETZGEN CO., NEW YORK.

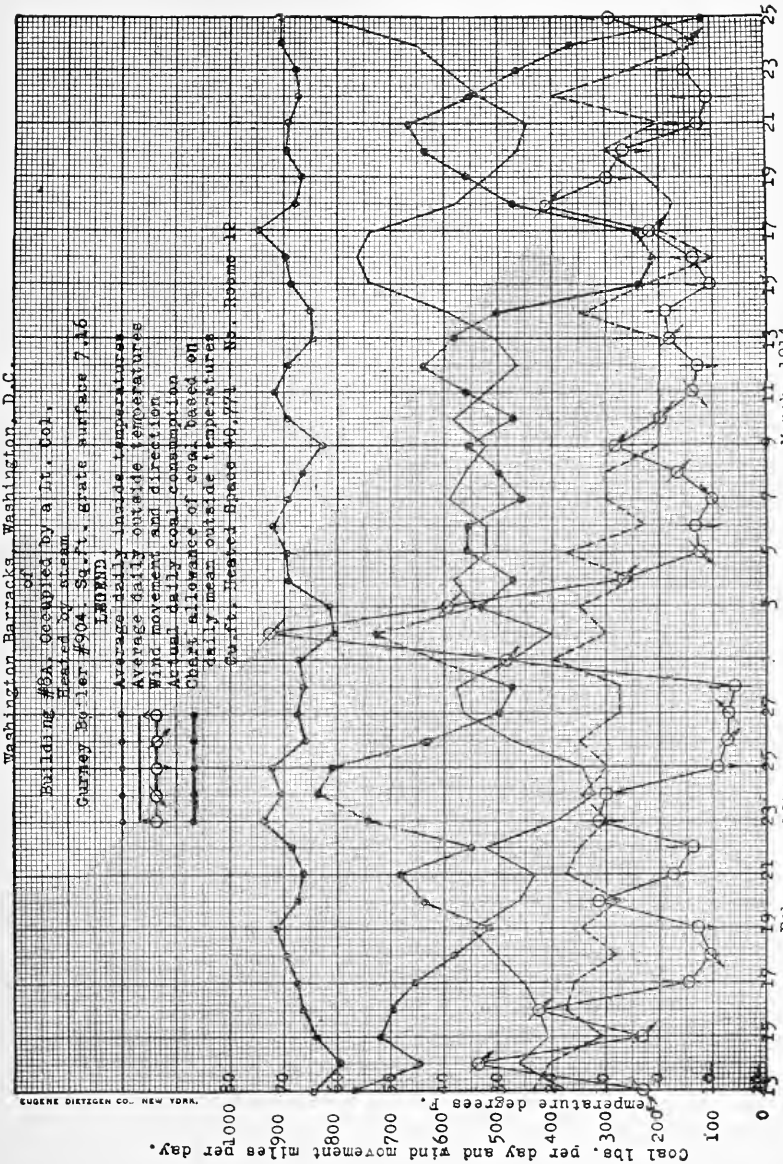

Daily record of temperatures and coal consumption
at
Washington Barracks, Washington, D.C.
Building #13A. Occupied by a 1st Lieut.
Heated by steam
Gurney Boiler #902. Sq.ft. grate surface 6.03
Pound.
Average daily inside temperatures
Average daily outside temperatures
Wind movement and direction
Actual daily coal consumption
Chart allowance of coal based on
daily mean outside temperatures.
Cu.ft. Heated Space 37,005 No. Rooms 10
Coal lbs. per day and wind movement miles per day.
Temperature degrees F.
February, 1914
March, 1914
EUGENE DIETZGEN CO., NEW YORK.

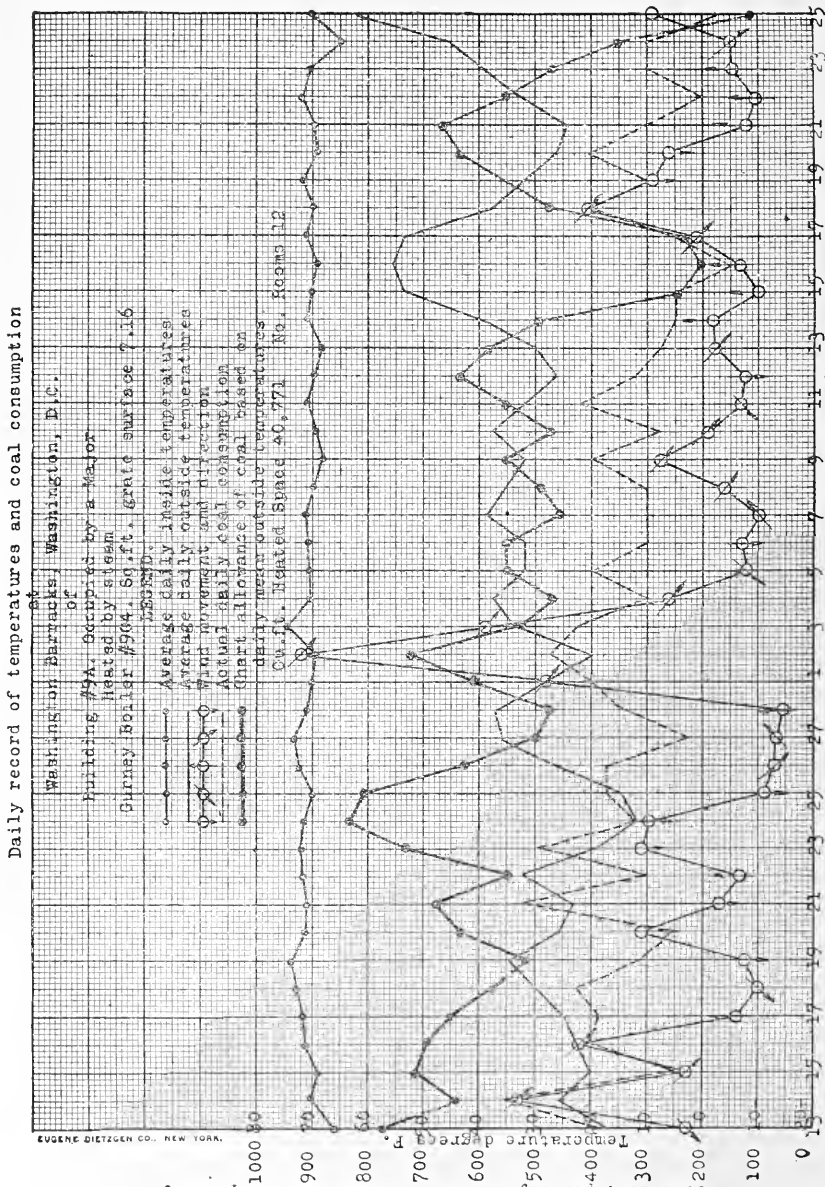
Daily record of temperatures and coal consumption
at
Washington Barracks, Washington, D.C.
of
Building #45, occupied by 9-1st Lieuts.; Batch A
Heated by steam
Gurney Boiler #402 30 sq.ft. grate surface 5.03
LEGEND.
Average daily hard temperatures
Average daily outside temperatures
Wind movement and direction
Actual daily coal consumption
Chart allowance of 0.81 based on
daily mean outside temperatures:
Cu.ft. heated space 30,683 No. Rooms 10
EUGENE DIETZGEN CO., NEW YORK.
Coal lbs. per day and wind movement miles per day.
Temperature degrees F.
February, 1914
March, 1914

Daily record of temperatures and coal consumption at Washington Barracks, Washington, D.C.

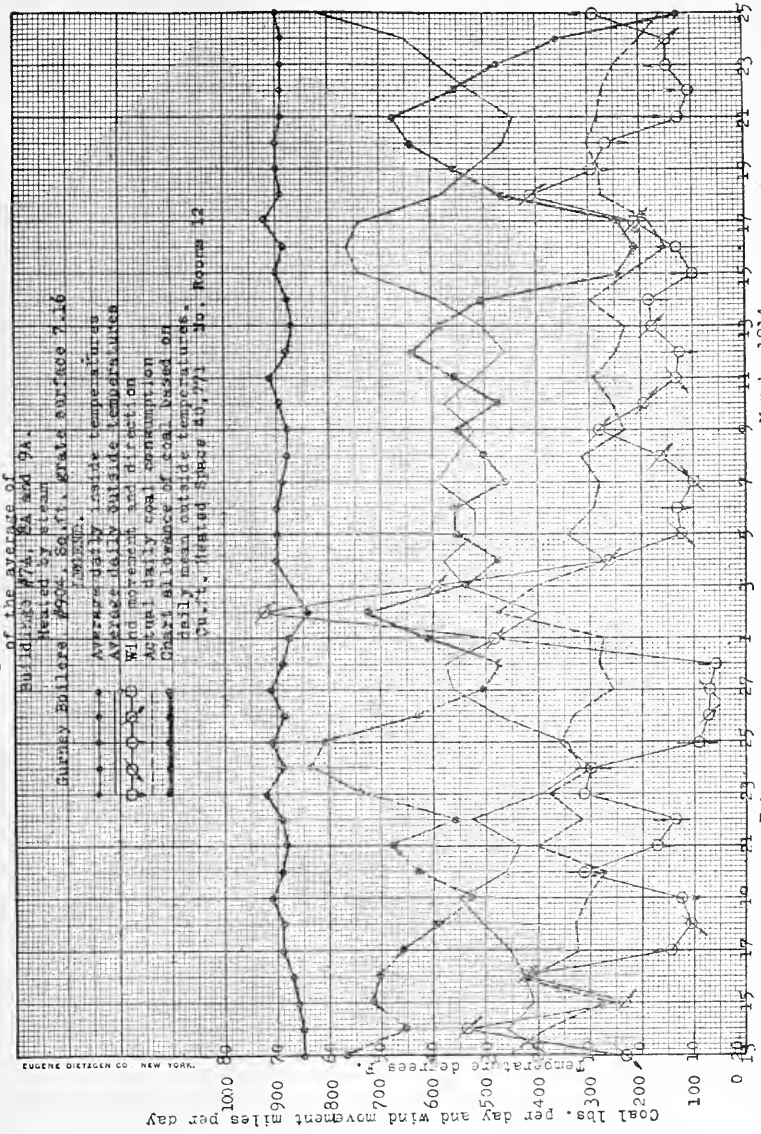


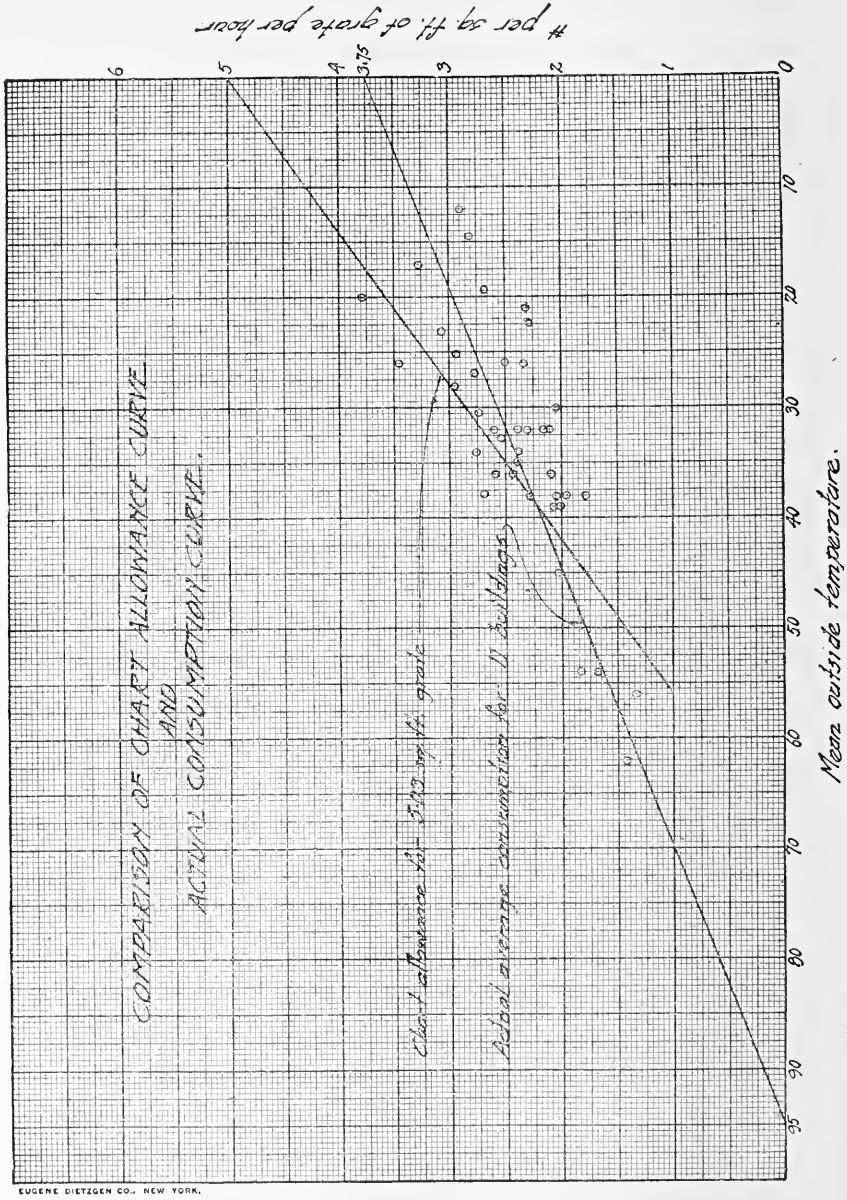

Daily record of temperatures and coal consumption
at
Washington Barracks, Washington, D.C.
Building #7A
Occupied by a Major
Heated by steam
Burner Boiler Wyo. Sq.ft. grate surface 7.16
Average daily inside temperatures
Average daily outside temperatures
Wind movement and direction
Actual daily coal consumption
Chart allowance of coal based on
daily mean outside temperatures
Curves Reduced Scale 40 mm = 30 Degrees F.
EUGENE DIETZGEN CO., NEW YORK.
Coal lbs. per day and wind movement miles per day.
Temperature degrees F.
February, 1914
March, 1914

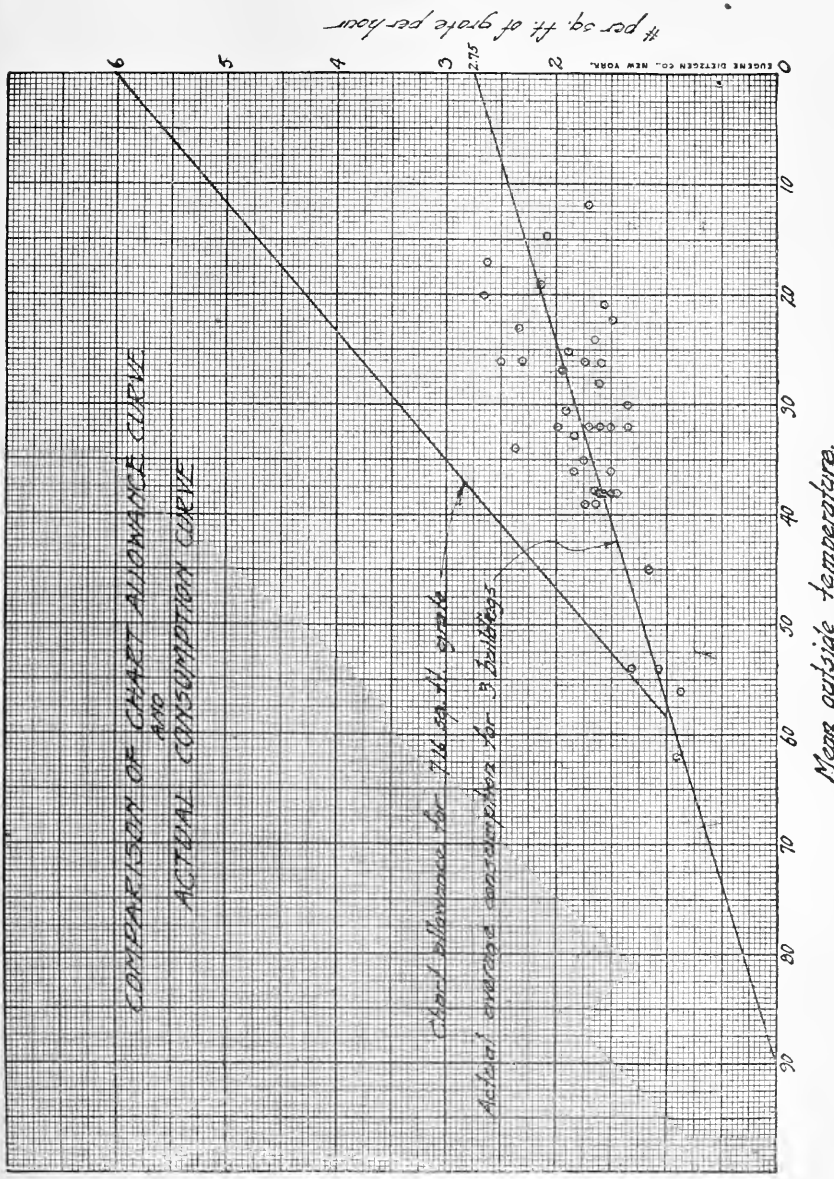

Daily record of temperatures and coal consumption
at
Washington Barracks, Washington, D.C.
Building #6A, occupied by 4 Lt. Col's.
Heated by steam
Curley Boiler #904, Sq.ft. Grate surface 7.16
LEGEND
Average daily inside temperatures
Average daily outside temperatures
Wind movement and direction
Actual daily coal consumption
Chart, showing amount of coal based on
daily mean outside temperatures
Chart, Heated Space #6,7,11 No. Rooms 12
Coal lbs. per day and wind movement miles per day.
Temperature degrees F.
February, 1914
March, 1914
EUGENE DIETZGEN CO., NEW YORK.

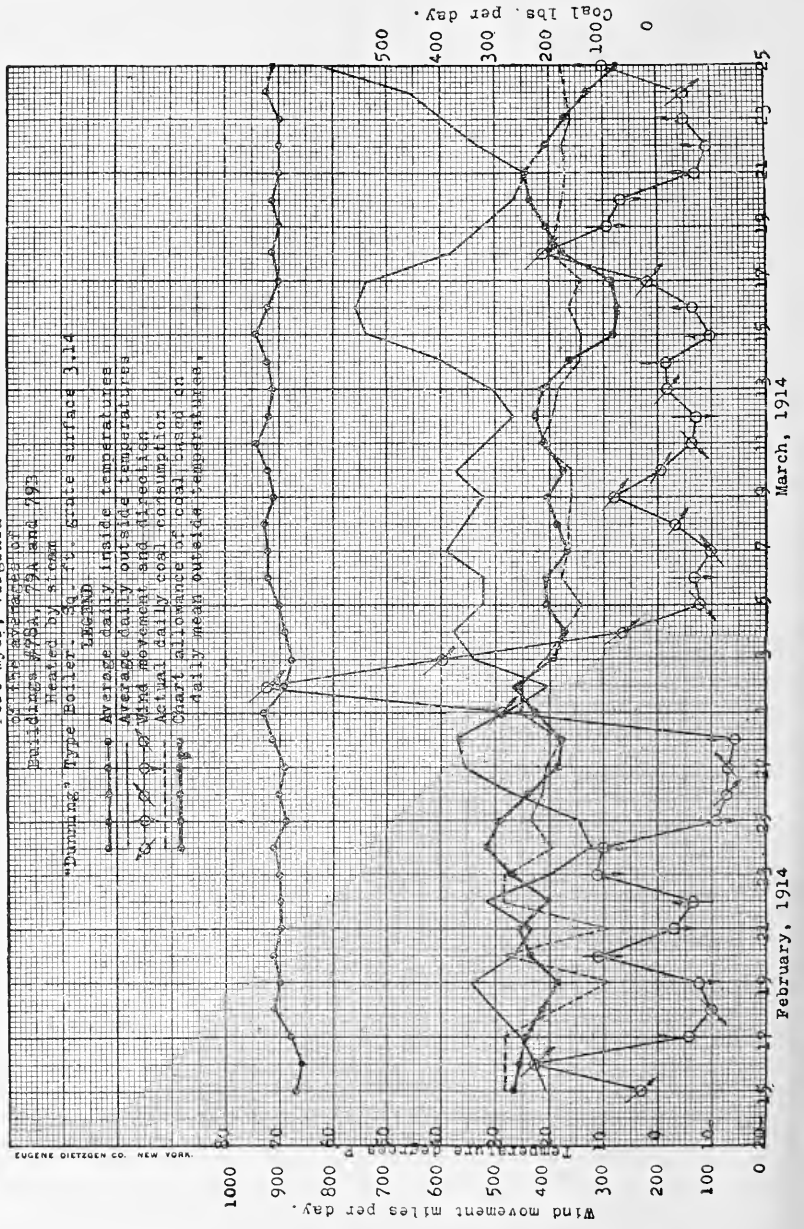

Daily record of temperatures and coal consumption
Washington Barracks, Washington, D.C.
of
Building #94, Occupied by a Major
Heated by steam
Gurney Boiler #904. Sq.ft. grate surface 7.16
Coal.
Average daily inside temperatures
Average daily outside temperatures
Mind movement and direction
Actual daily coal consumption
Chart allowance of coal based on
daily mean outside temperatures
Coal. Heated Space 40,772 Sq. Feet
EUGENE DIETZGEN CO., NEW YORK.
Coal lbs. per day and wind movement miles per day.
Temperature degrees F.
February, 1914
March, 1914

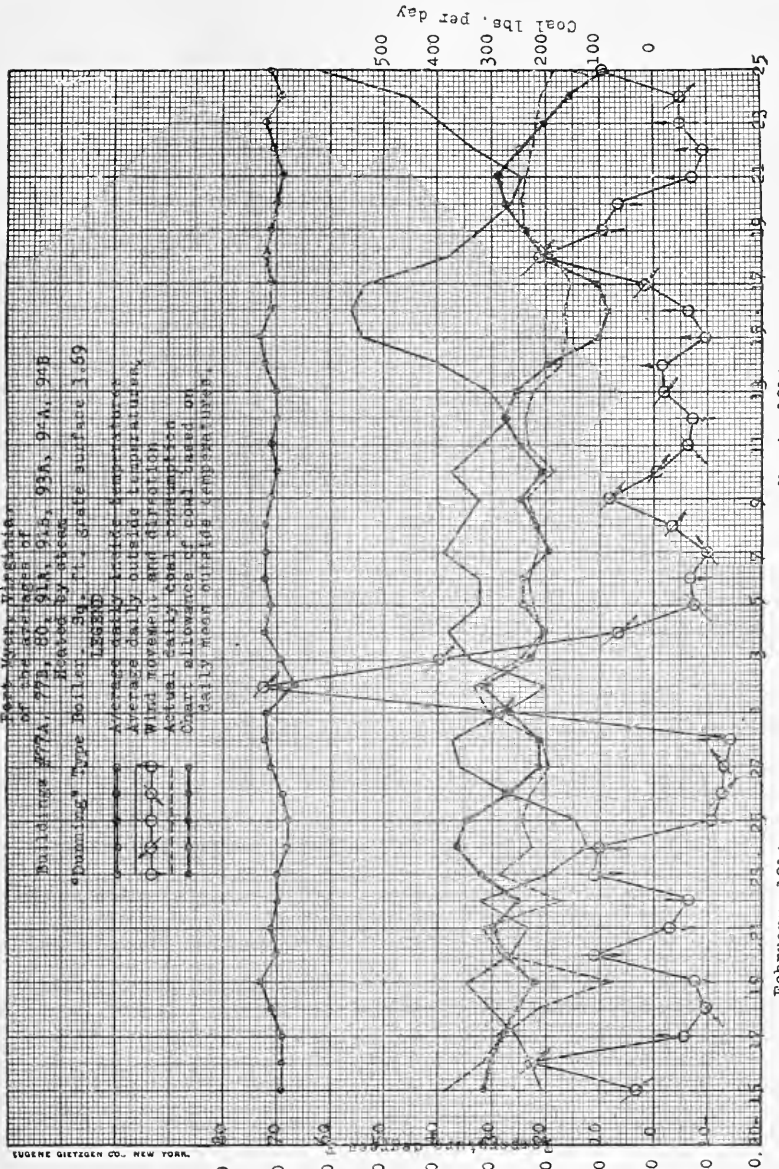
Daily record of temperatures and coal consumption at Washington Barracks, Washington, D.C.

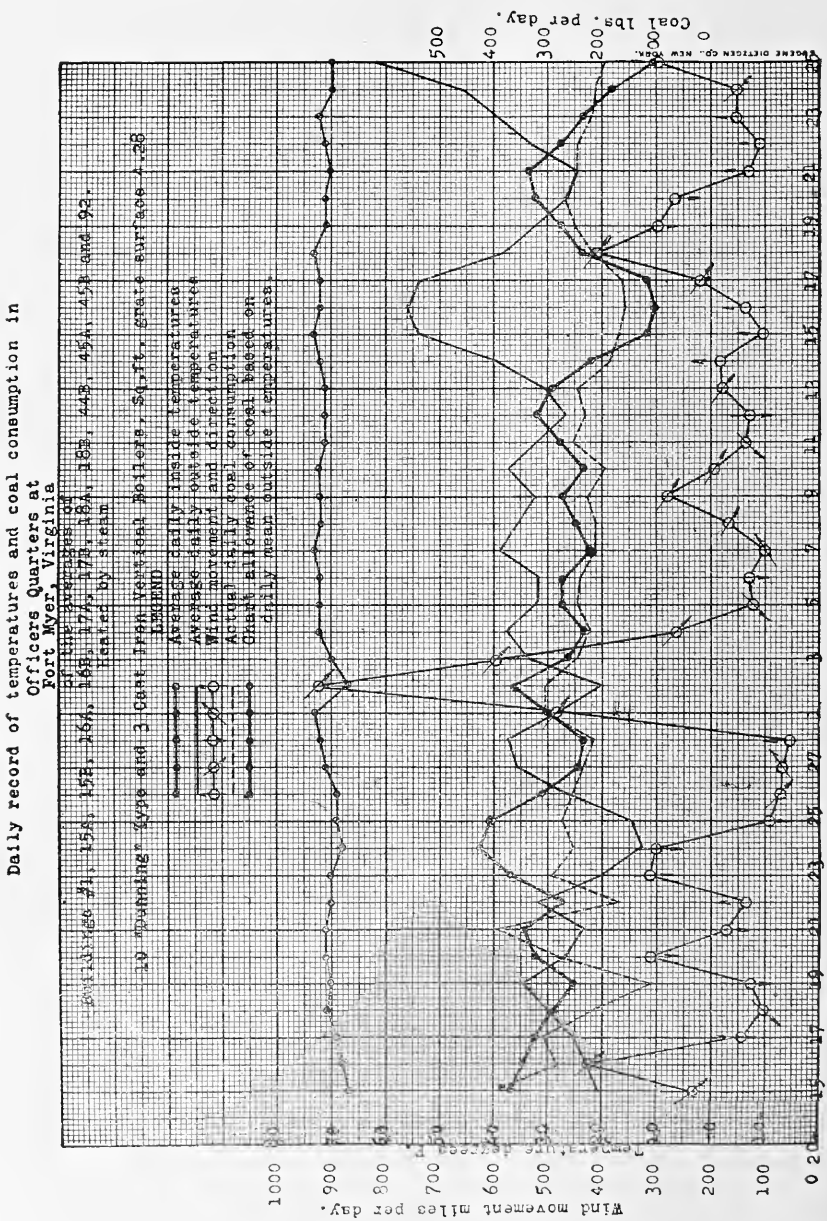



per sq. ft. of grate per hour
Mean outside temperature.
COMPARISON OF CHART ALLOWANCE CURVE AND ACTUAL CONSUMPTION CURVE.
Chart allowance with 1.25 lbs. per sq. ft. grate
Actual average consumption for 11 boilers
EUGENE DIETZGEN CO., NEW YORK.

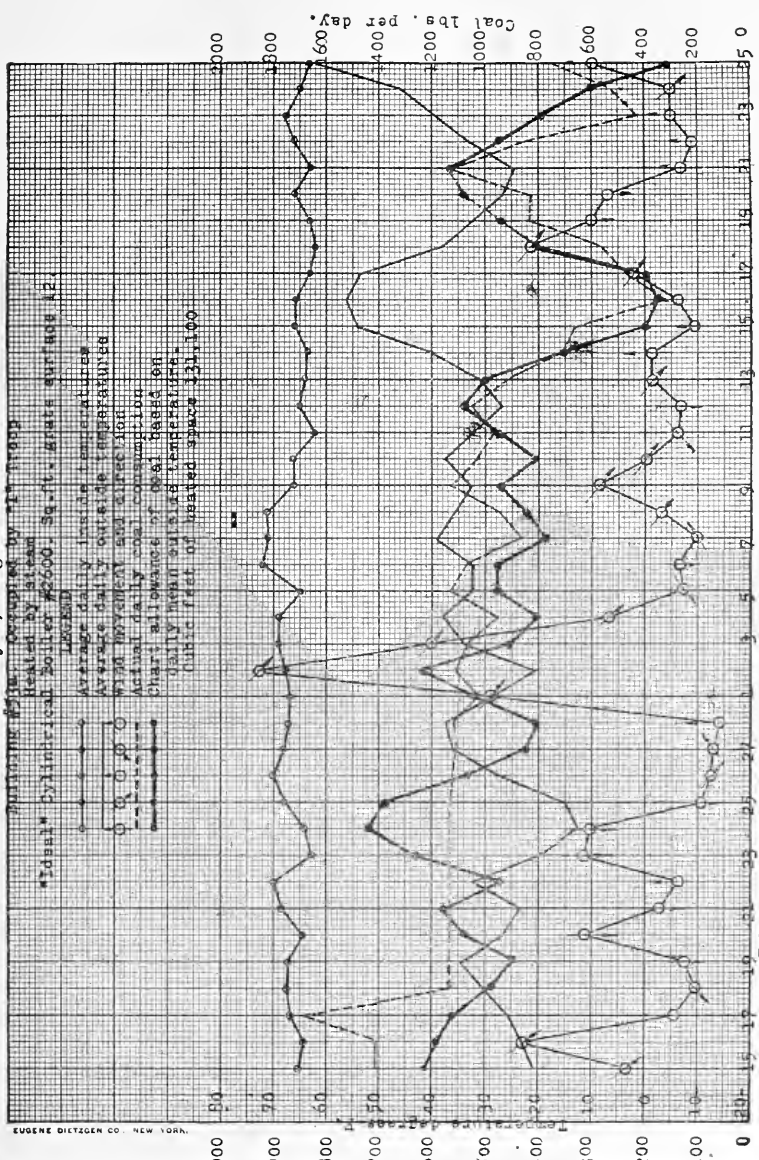

EUGENE DIETZGEN CO. NEW YORK.
per sq. ft. of grate per hour
Mean outside temperature.
COMPARISON OF COAL ALLOWANCE CURVE AND ACTUAL CONSUMPTION CURVE
Coal allowance for the 24 hr. steam
Actual steam generated per pound of coal by Babcock's

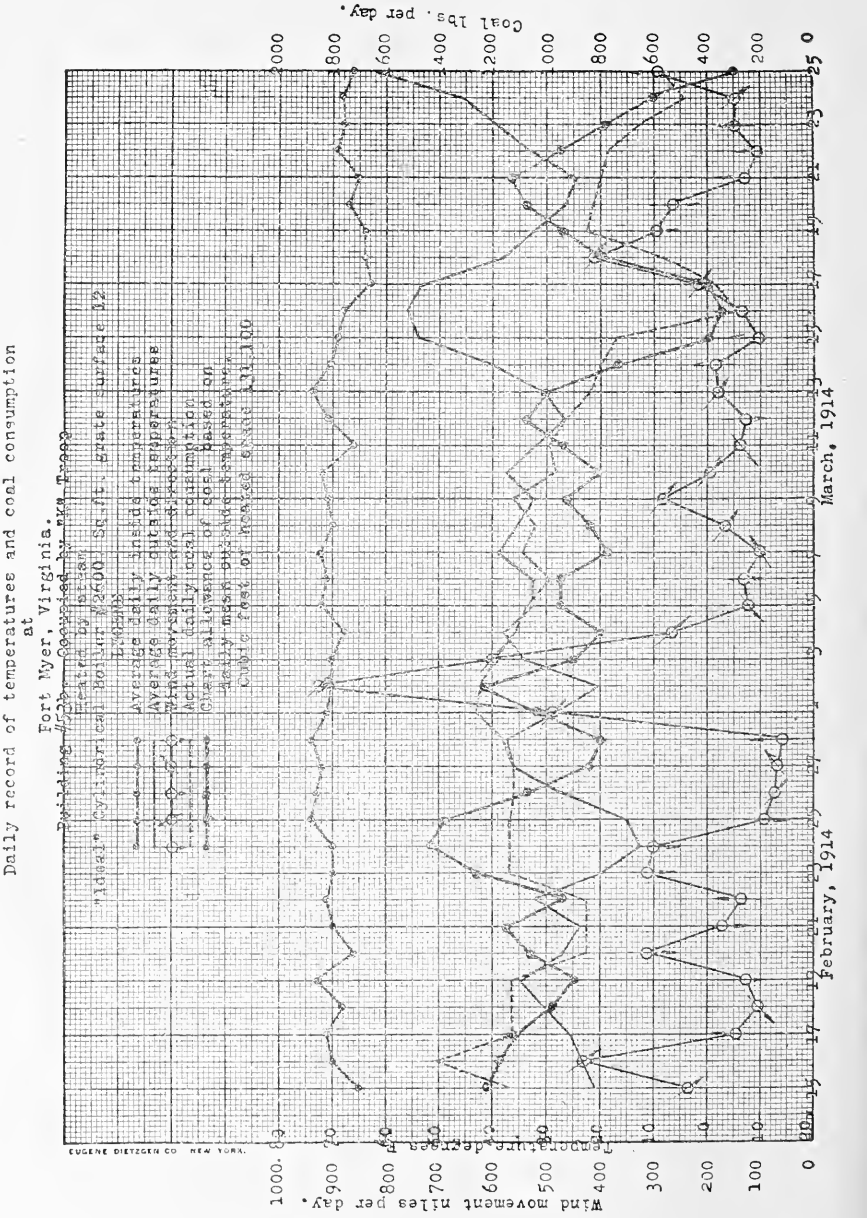

Daily record of temperatures and coal consumption in three five room Officers Quarters at Fort Myer, Virginia
Of the average temperature
Buildings #79A, #79B and #79C
Heated by steam
"Dunning" Type Boiler. 30 sq. ft. Grate surface 3.14
LEGEND
Average daily inside temperatures
Average daily outside temperatures
Wind movement and direction
Actual daily coal consumption
Chart allowance of coal based on
daily mean outside temperatures
Wind movement miles per day.
Temperature degrees F.
Coal lbs. per day.
February, 1914
March, 1914
EUGENE DIETZGEN CO. NEW YORK.


Daily record of temperatures and coal consumption in Officers Quarters at
Fort Monroe, Virginia.
Building #77A, 80, 91A, 91B, 93A, 94A, 94B
Heated by steel "Dunning" Type Boiler, 38 sq. ft. grade surface 1.69
LEGEND
Average daily outside temperature.
Average daily outside temperature.
Wind movement and direction.
Actual daily coal consumption
Coal allowance of coal based on daily mean outside temperatures.
Wind movement miles per day.
Coal lbs. per day
February, 1914
March, 1914
EUGENE DIETZGEN CO., NEW YORK.

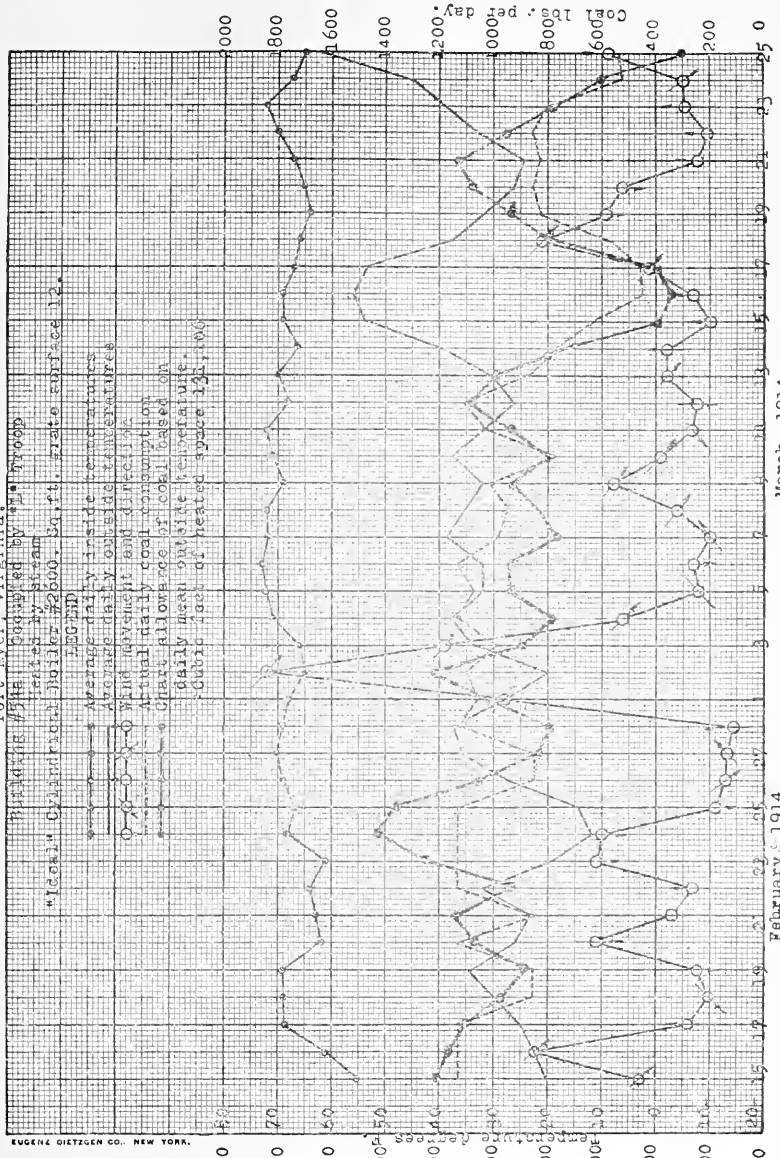

Daily record of temperatures and coal consumption in
Officers Quarters at
Fort Myer, Virginia
Coal lbs. per day.
Wind movement miles per day.
February, 1914
March, 1914

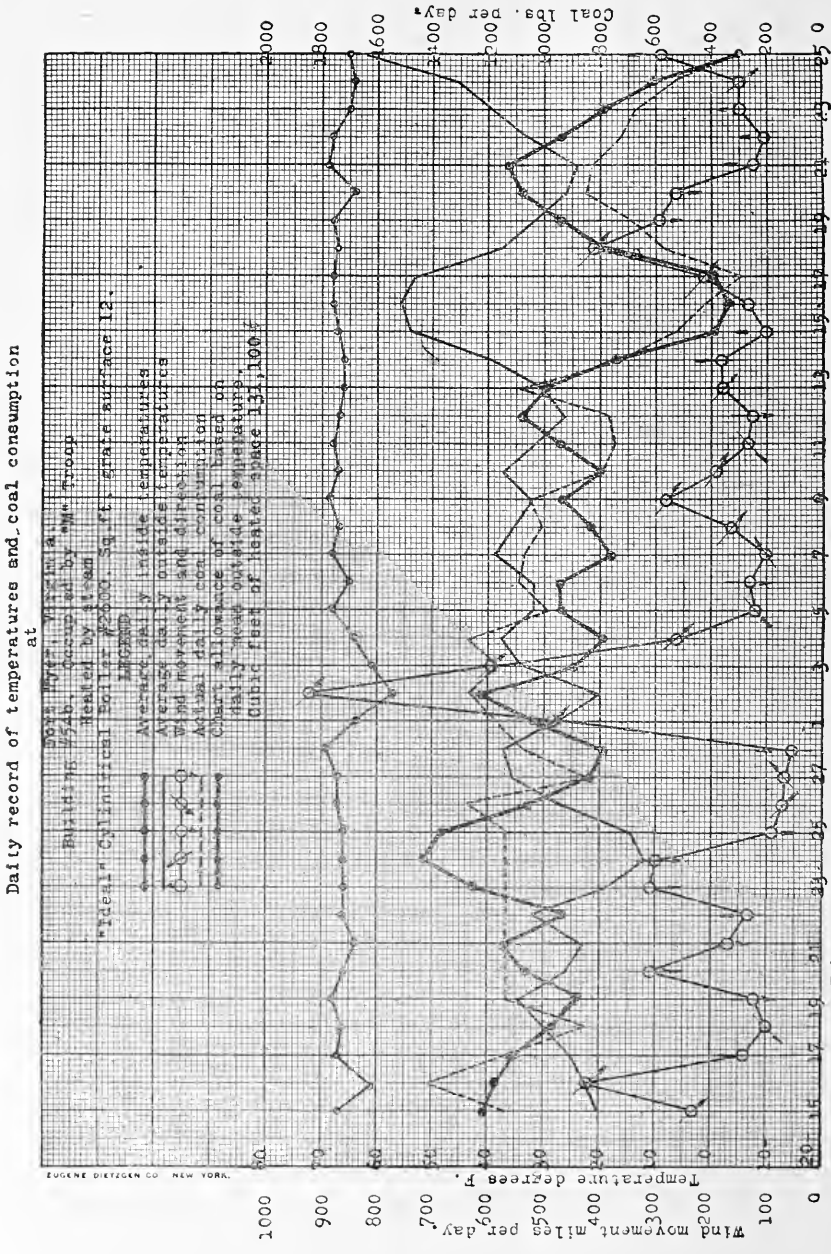
Daily record of temperatures and coal consumption at Fort Myer, Virginia.



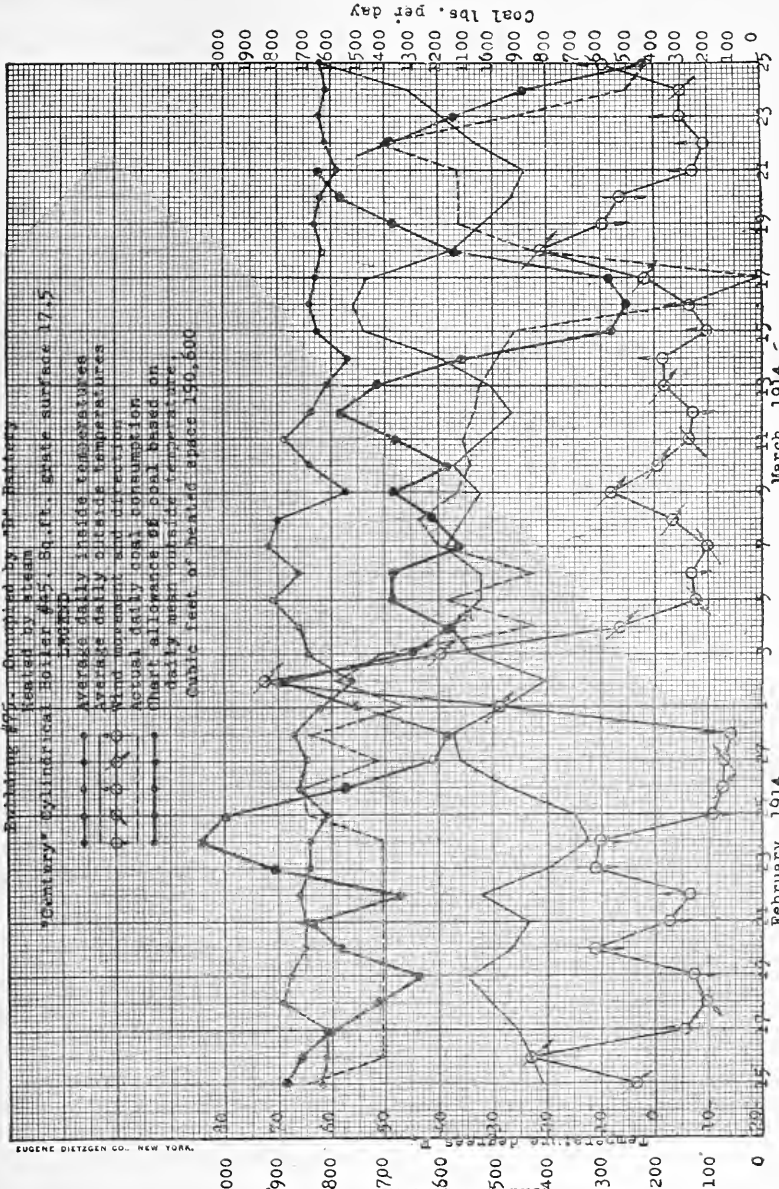

Daily record of temperatures and coal consumption
at
Fort Myer, Virginia.
Building 323. Connected by 4" Trap
Fitted by Sear
"Ideal" Cylindrical Boiler #2600 Sq. Ft. Grate Surface 12
Lbs. Coal
Average daily inside temperatures
Average daily outside temperatures
Wind movement miles per day
Actual daily coal consumption
Chart allowance of coal based on
daily mean inside temperature
Cubic feet of water evaporated per lb. coal
Wind movement miles per day.
Temperature degrees F.
Coal lbs. per day.
February, 1914
March, 1914
EUGENE DIETZGEN CO. NEW YORK.

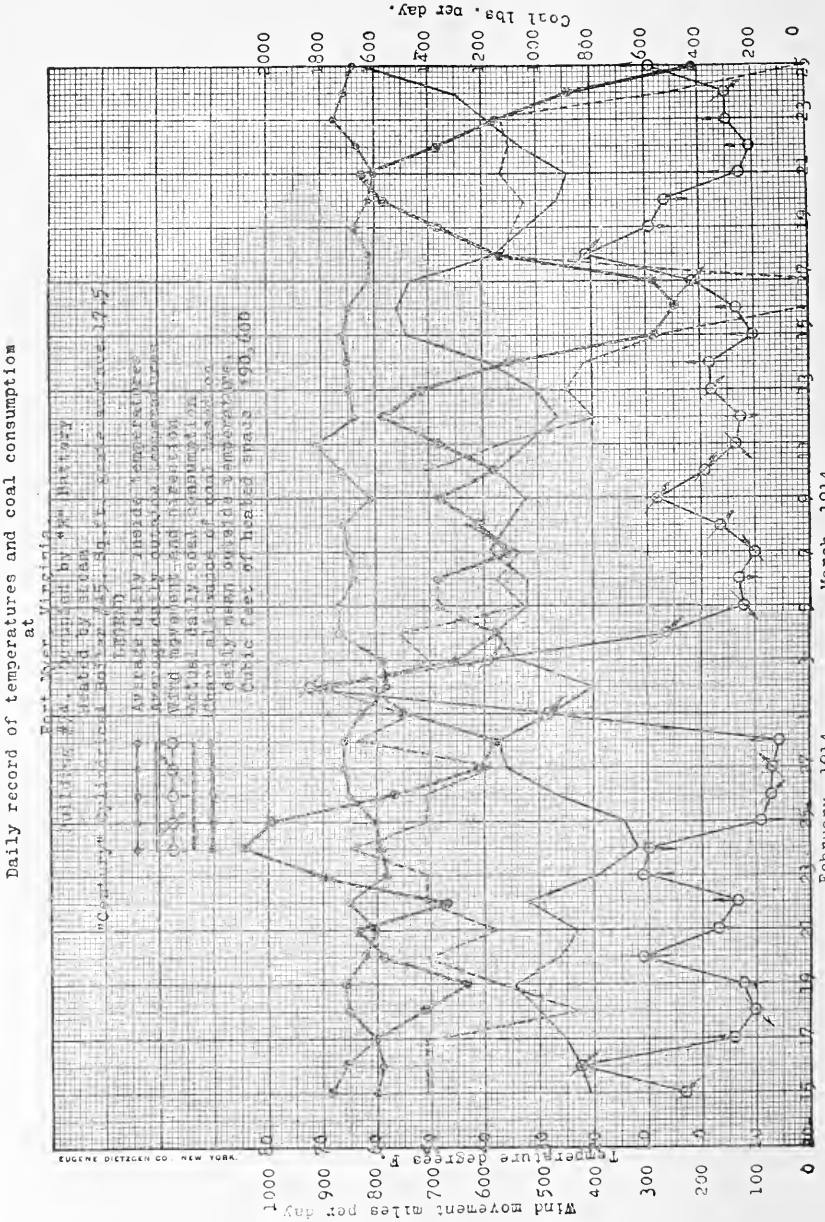
Daily record of temperatures and coal consumption
at
Fort Myer, Virginia.

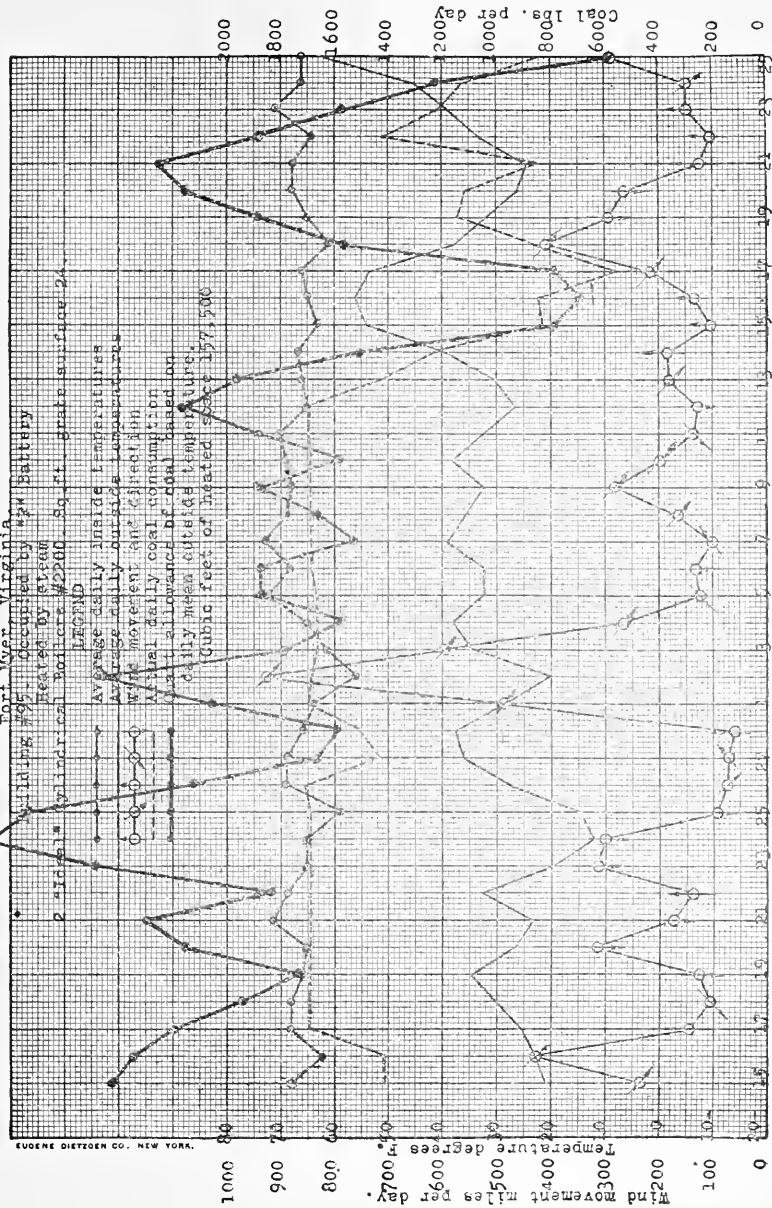


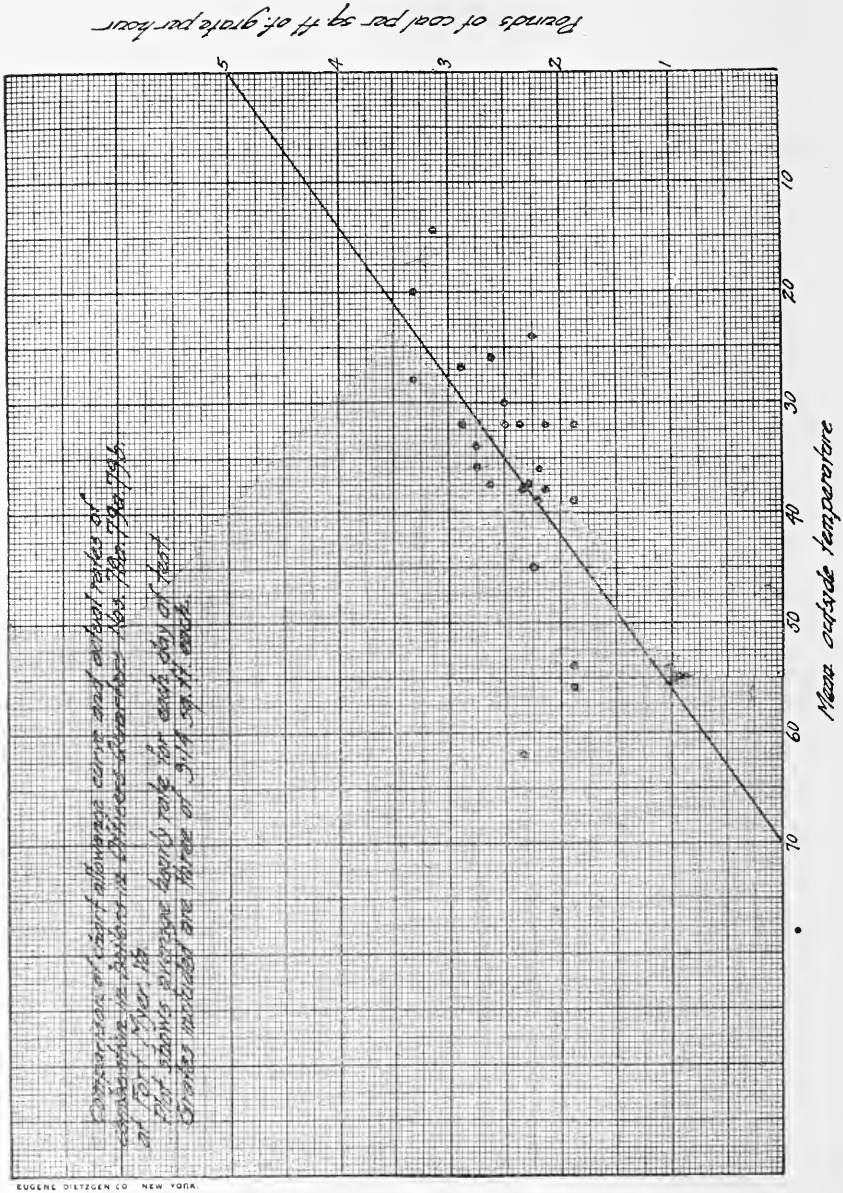

Daily record of temperatures and coal consumption at
Bath, Virginia
Building #56. Occupied by "W" Troop
Heated by steam
"Ideal" Cylindrical Boiler #2600. Sq. ft. grate surface 12.
LEGEND
Average daily inside temperatures
Average daily outside temperatures
Wind movement and direction
Actual daily coal consumption
Chart allowance of coal based on daily mean outside temperature.
Cubic feet of heated space 133,100
Wind movement, miles per day.
Temperature degrees F.
Coal lbs. per day.
February, 1914
March, 1914
EUGENE DIETZGEN CO. NEW YORK.

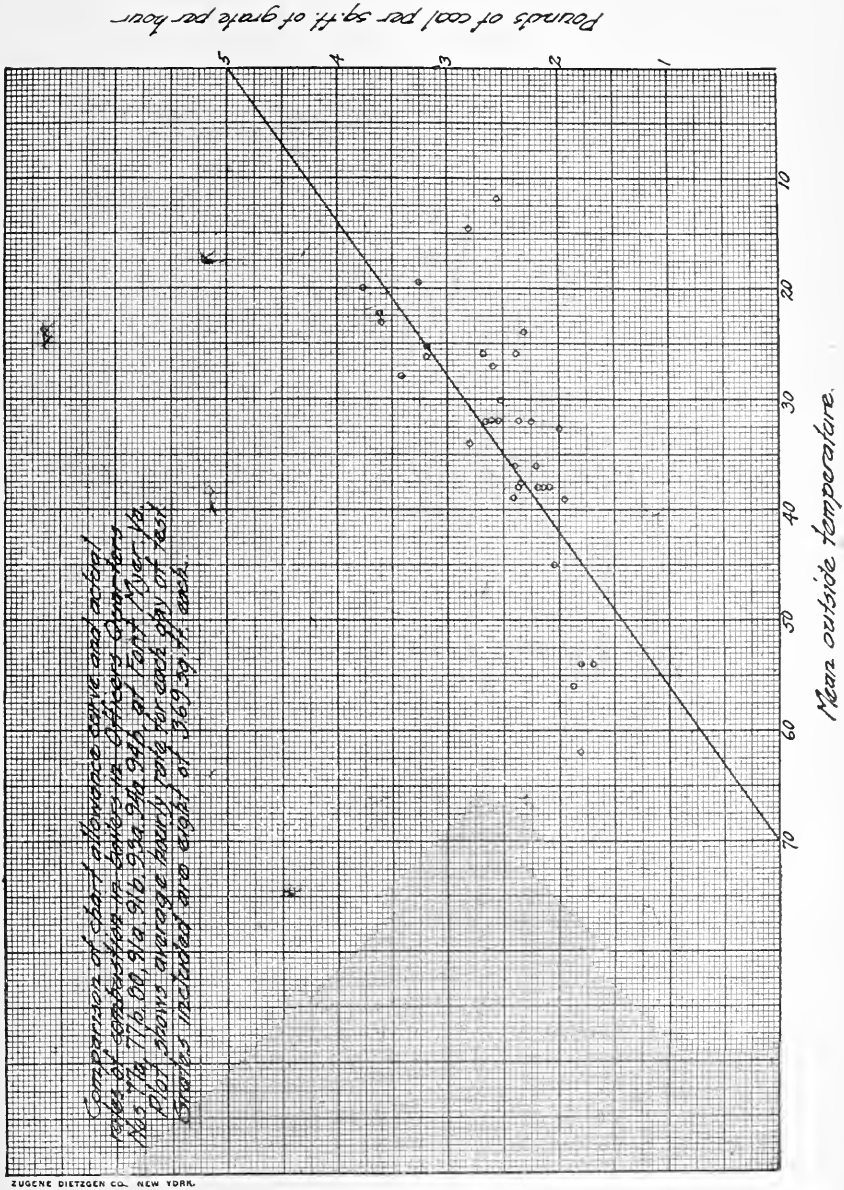
Daily record of temperatures and coal consumption at Fort Myer, Virginia.

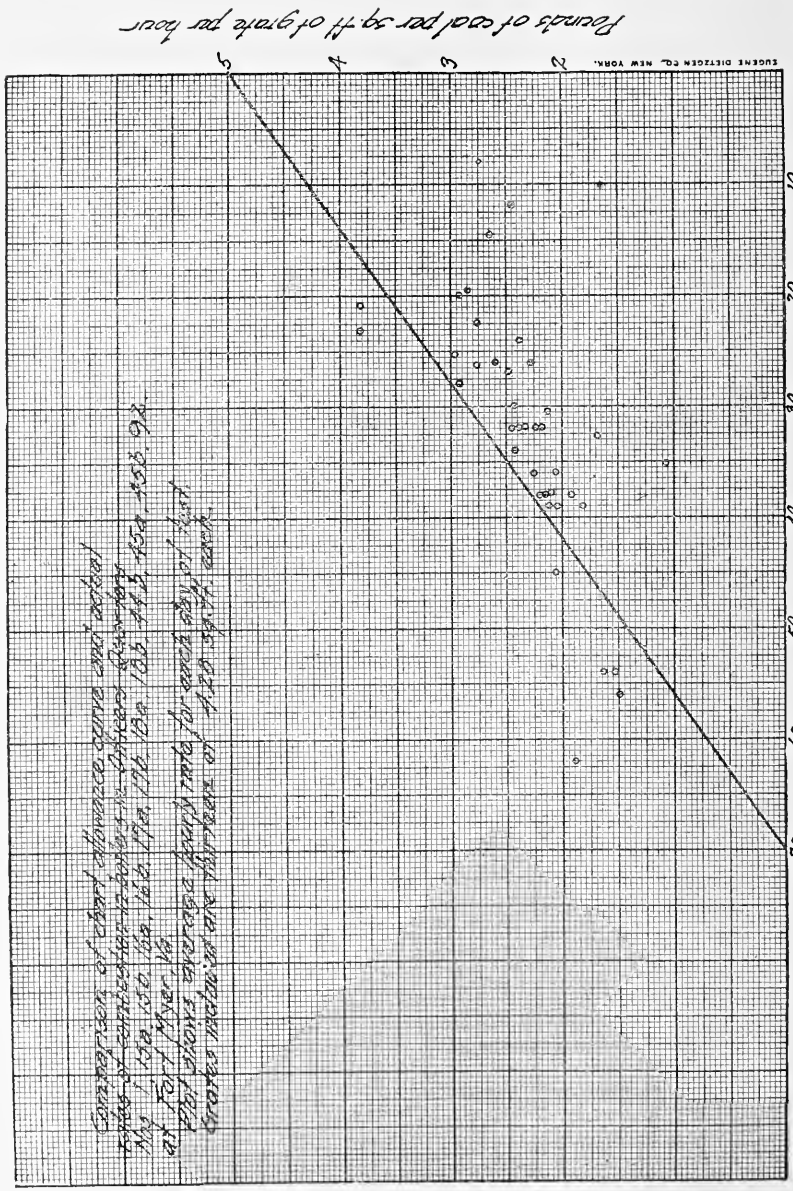


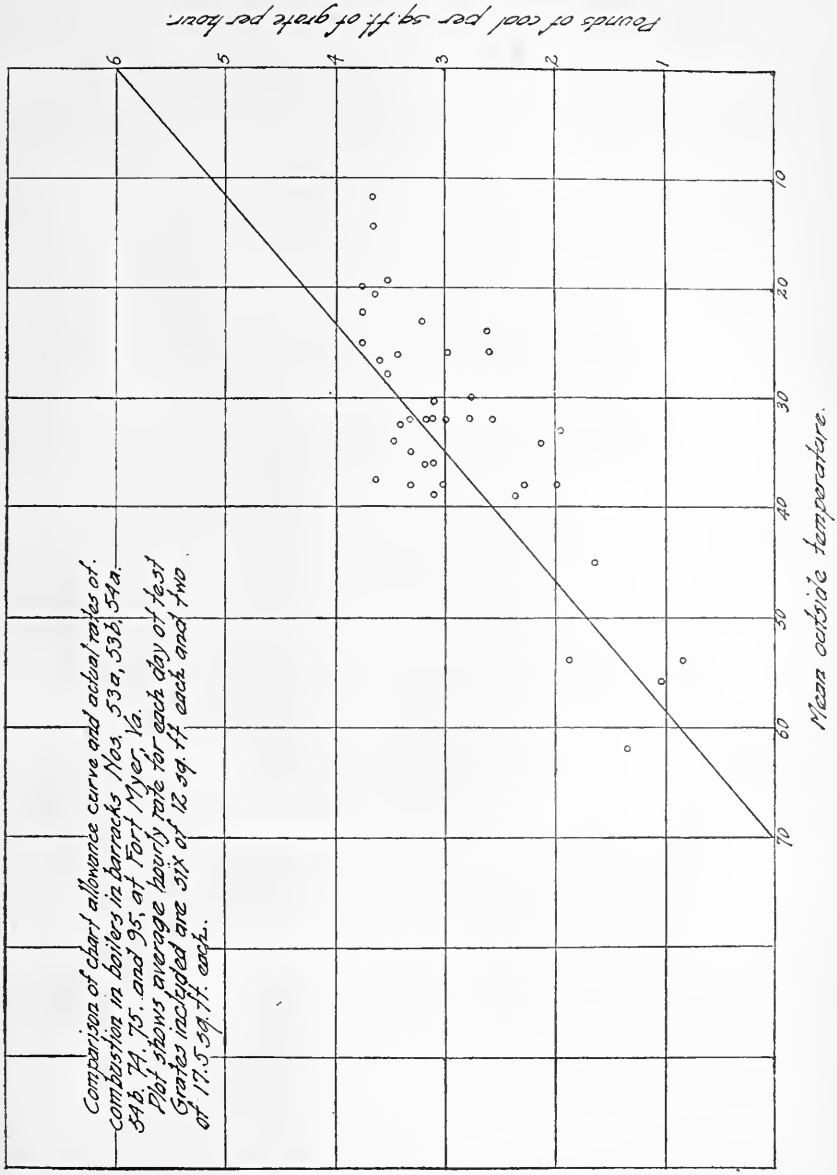

Daily record of temperatures and coal consumption
at
Fort Dyer, Virginia.
Coal lbs. per day.
Temperature degrees F.
Wind movement miles per day.
February, 1914
March, 1914
EUGENE DIETZGEN CO. NEW YORK.

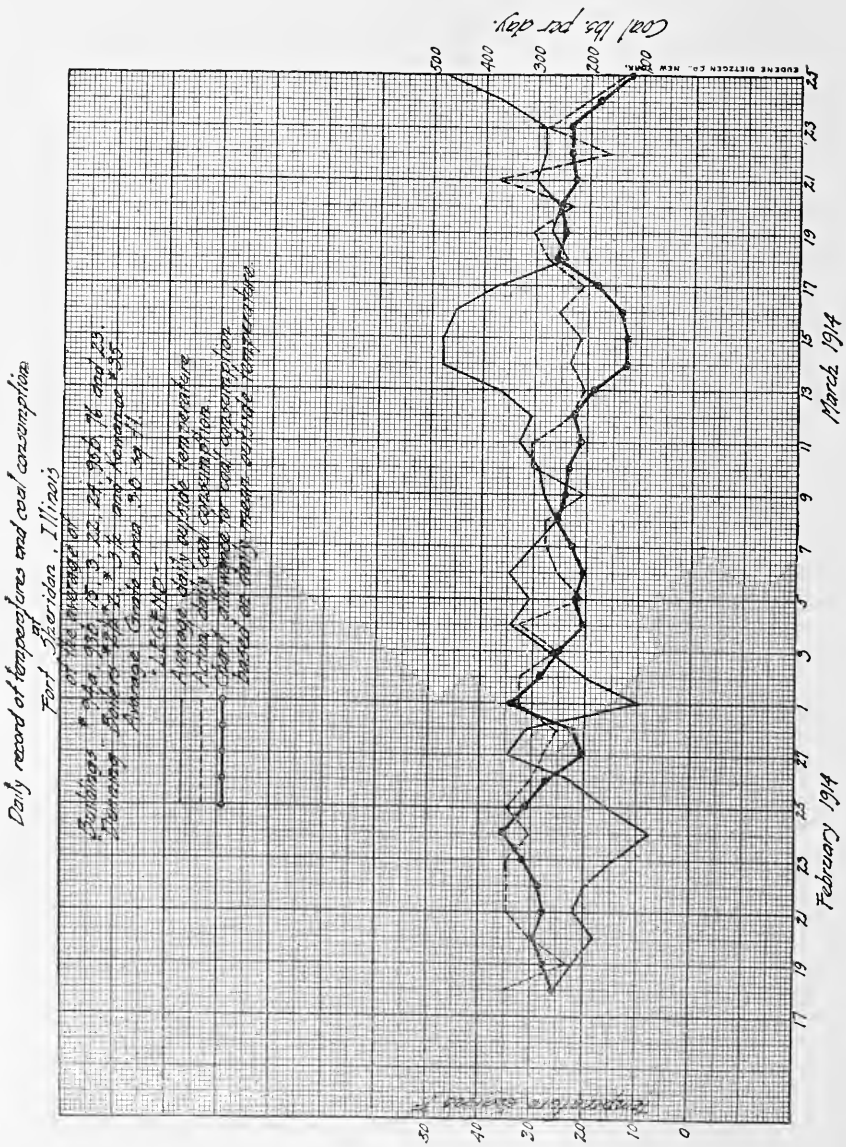

Daily record of temperatures and coal consumption
at
Port Wyer, Virginia.
Building No. 1. Occupied by 1st Battery
Heated by steam
2 Babcock & Wilcox 2200 sq. ft. grate surface 24.
Wind movement and direction.
Actual daily coal consumption.
Daily allowance of coal based on
daily mean outside temperature.
Cubic feet of heated space 157,500
Wind movement miles per day.
Temperature degrees F.
Coal lbs. per day.
February, 1914
March, 1914
EUGENE DIETZGEN CO. NEW YORK.

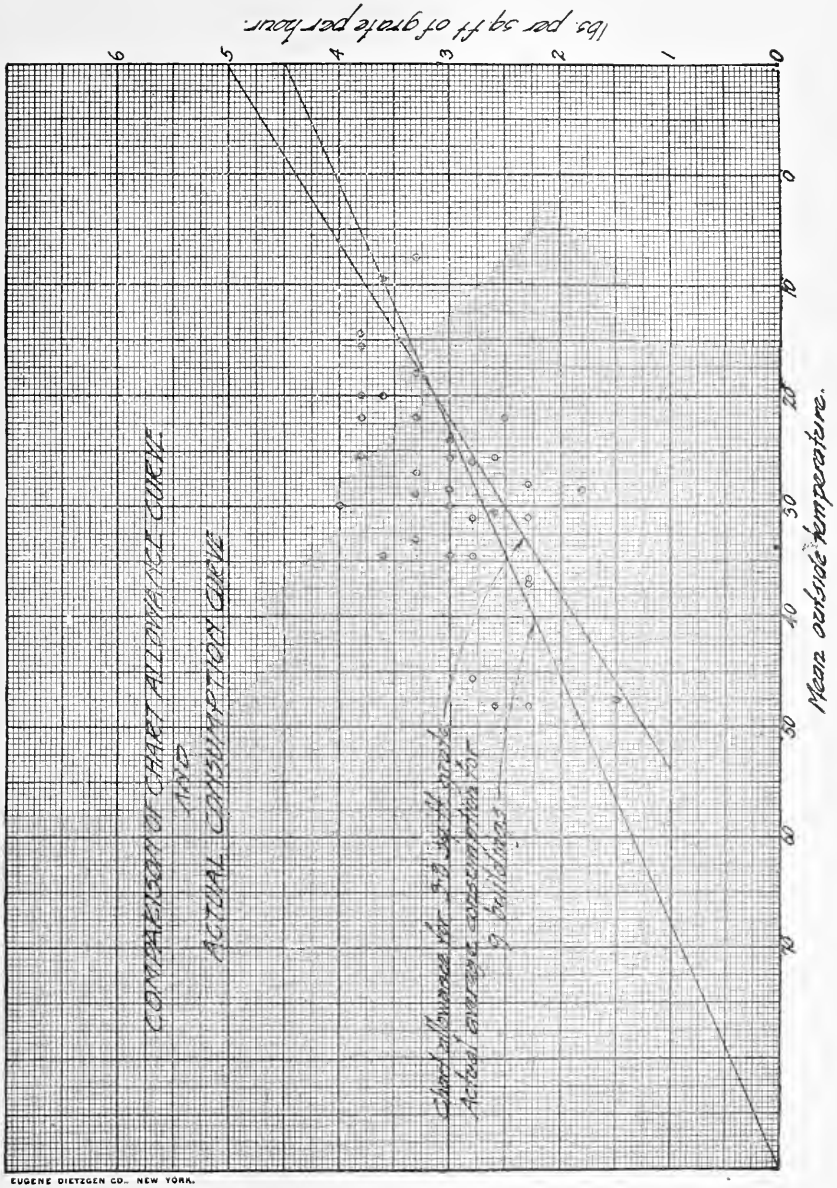

Pounds of coal per sq ft of grate per hour
5
4
3
2
1
10
20
30
40
50
60
70
Mean outside temperature
EUGENE DIETZGEN CO NEW YORK


Pounds of coal per sq. ft. of grate per hour.
5
4
3
2
1
10
20
30
40
50
60
70
Mean outside temperature.
ZUGENE DIETZGEN CO. NEW YORK.

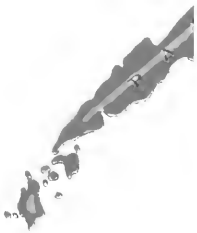

Pounds of coal per sq. ft of grate per hour
Mean outside temperature
EUGENE DIETZGEN CO. NEW YORK.

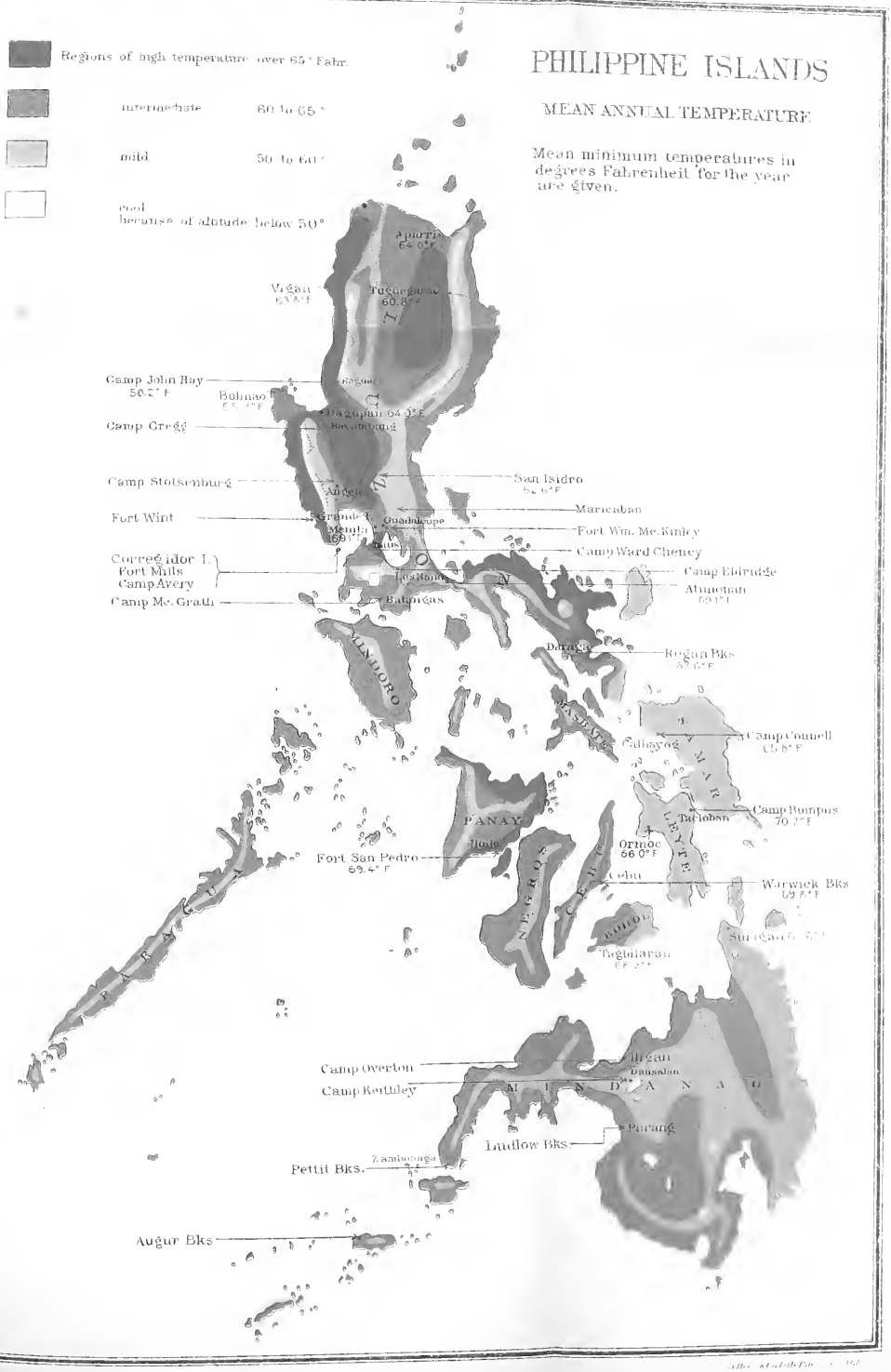

Pounds of coal per sq ft of grate per hour.
6
5
4
3
2
1
10
20
30
40
50
60
70
Mean outside temperature.
Comparison of chart allowance curve and actual rates of combustion in boilers in barracks Nos. 53a, 53b, 54a, 54b, 74, 75, and 95, at Fort Myer, Va.
Plot shows average hourly rate for each day of test
Grates included are six of 12 sq. ft. each and two of 17.5 sq. ft. each.

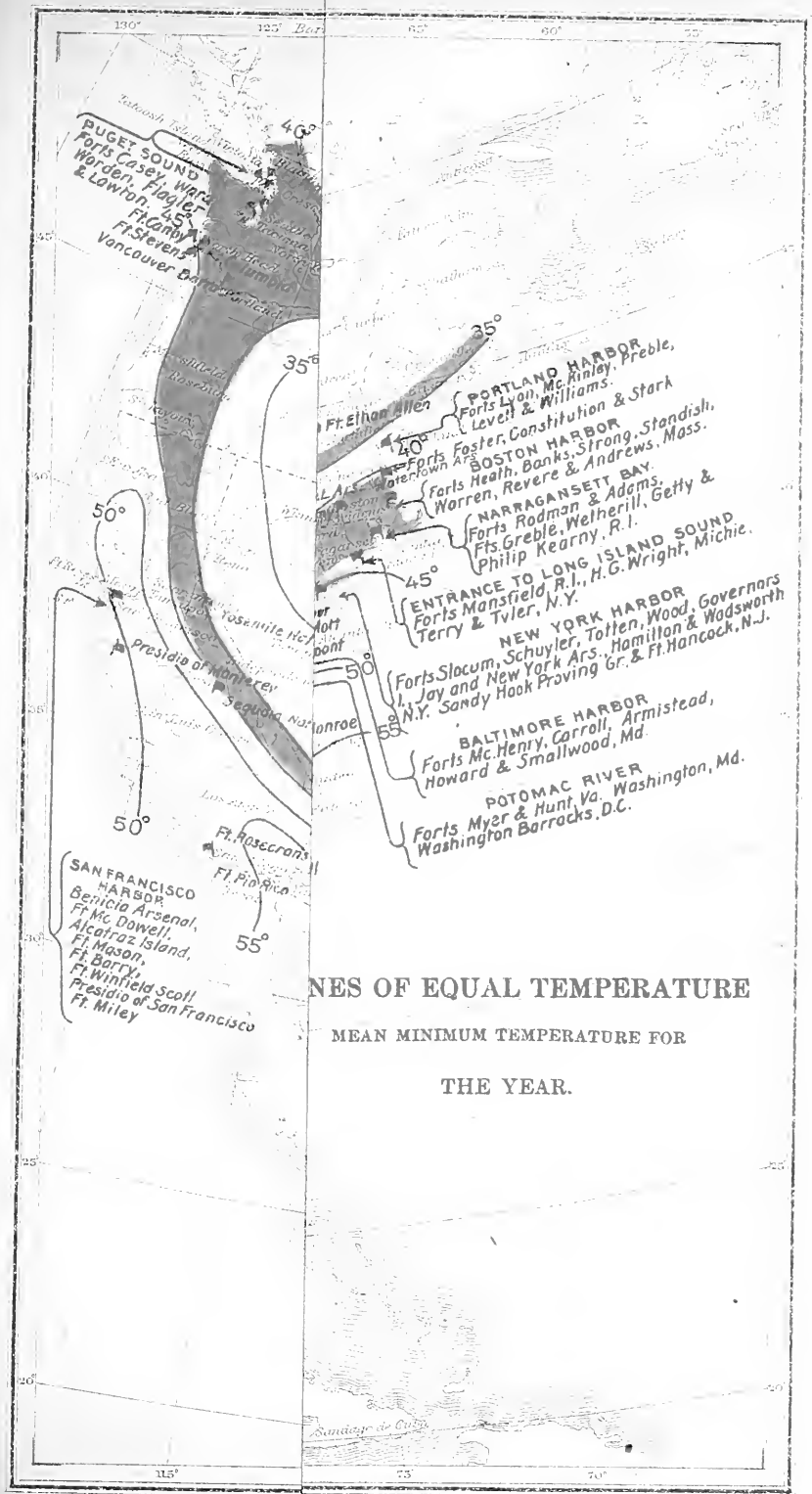

Daily record of temperatures and coal consumption
at
Fort Sheridan, Illinois
Coal lbs. per day.
Temperature Fahrenheit
February 1914
March 1914
EUGENE DIETZGEN CO. NEW YORK


lbs. per sq ft of grate per hour.
Mean outside temperature.
COMPARISON OF CHART ALLOWANCE CURVE AND ACTUAL CONSUMPTION CURVE
EUGENE DIETZGEN CO., NEW YORK.

53096°—14——10




PHILIPPINE ISLANDS
MEAN ANNUAL TEMPERATURE
Mean minimum temperatures in degrees Fahrenheit for the year are given.
Regions of high temperature over 65° Fahr.
intermediate 60 to 65°
mild 50 to 60°
cool because of altitude below 50°
Aparri 64.0°F
Vigan 63.8°F
Tuguegarao 60.8°F
Camp John Hay 50.2°F
Baguio
Bolinao 65.4°F
Dagupan 64.0°F
Camp Gregg
Camp Stotsenburg
Angeles
San Isidro 62.6°F
Fort Wint
Grande I.
Cavite
Maricaban
Manila 69.1°F
Quadrupe
Fort Wm. McKinley
Cabanatuan
Camp Ward Cheney
Corregidor I.
Fort Mills
Camp Avery
Los Baños
Camp Eldridge
Atimonan 69.1°F
Camp Mc. Grath
Batangas
Daraga
Region Bks 67.6°F
MINDORO
MASBATE
Camp Connell 65.8°F
Calbayog
SAMAR
Tacloban
Camp Rumpus 70.7°F
PANAY
Iloilo
Ormoc 66.0°F
LEYTE
Fort San Pedro 69.4°F
Cebu
Warwick Bks 69.8°F
NEGROS
BOHOL
Tagbilaran 68.2°F
PALAWAN
Camp Overton
Iligan
Dansalan
Camp Keithley
MINDANAO
Parang
Ludlow Bks
Zamboanga
Pettit Bks.
Augur Bks

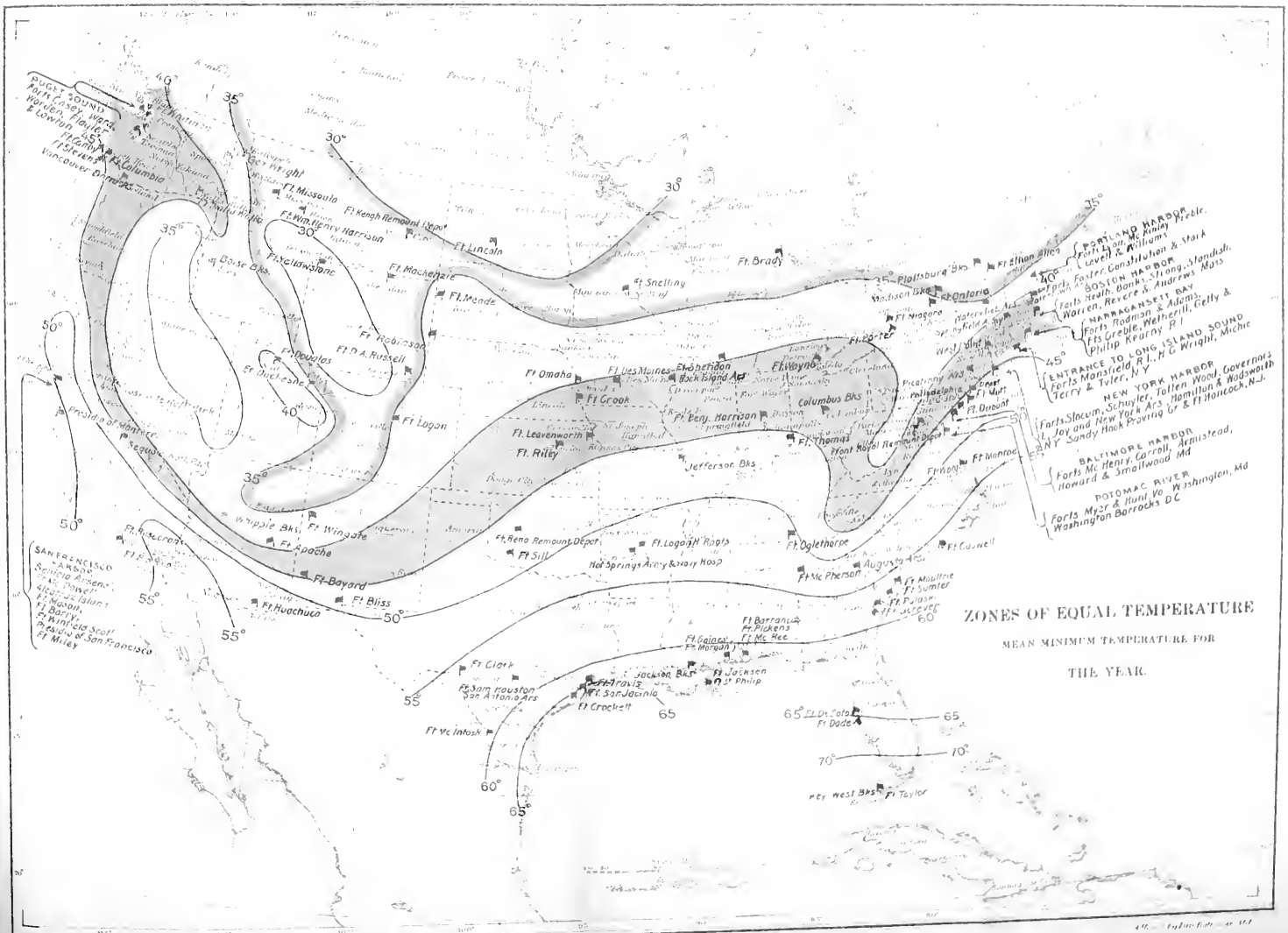


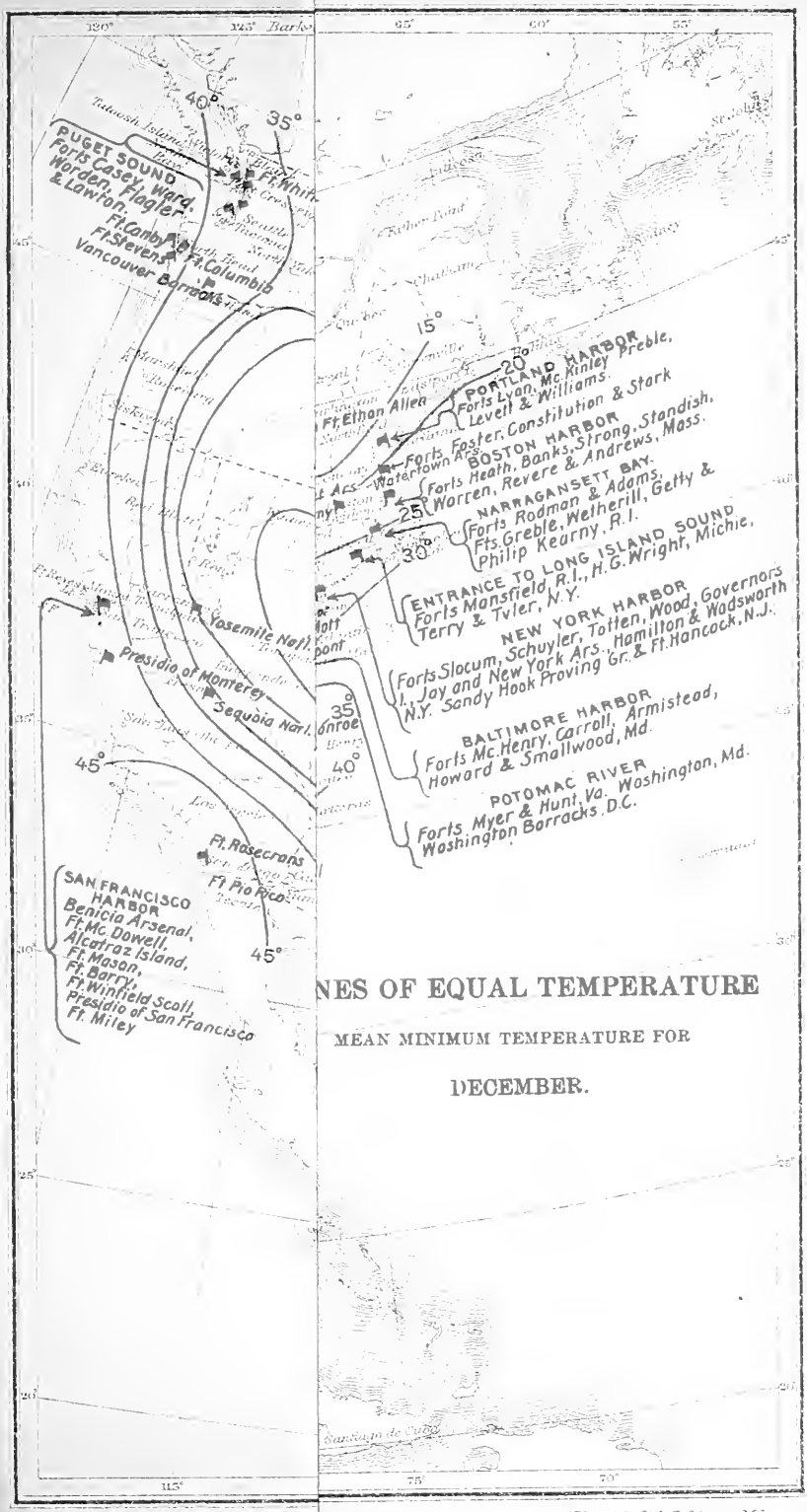
NES OF EQUAL TEMPERATURE

MEAN MINIMUM TEMPERATURE FOR

THE YEAR.

A.Hoen & Co Lith. Baltimore Md.


ZONES OF EQUAL TEMPERATURE
MEAN MINIMUM TEMPERATURE FOR
THE YEAR.
Puget Sound
Port Townsend
Port Angeles
Fort Canby
Fort Stevens
Vancouver Barracks
Fort Columbia
Fort Spokane
Fort Wright
Fort Missoula
Fort Keogh Remount Depot
Fort Custer
Fort Washakie
Fort Harrison
Fort Lincoln
Fort Yellowstone
Fort Mackenzie
Fort Meade
Fort Brady
Fort Snelling
Fort Robinson
Fort D. A. Russell
Fort Douglas
Fort Duchesne
Fort Logan
Fort Omaha
Fort Des Moines
Fort Sheridan
Rock Island Arsenal
Fort Wayne
Fort Porter
Fort Niagara
Fort Ontario
Plattsburg Bks
Fort Ethan Allen
Fort Leavenworth
Fort Riley
Fort Crook
Fort Benj. Harrison
Columbus Bks
Fort Thomas
Front Royal Remount Depot
Fort Mott
Fort Dupont
Fort Monroe
Fort Myer
Jefferson Bks
Fort Wingate
Fort Apache
Whipple Bks
Fort Bayard
Fort Huachuca
Fort Bliss
Fort Reno Remount Depot
Fort Sill
Fort Logan H. Roots
Hot Springs Army & Navy Hosp
Fort Oglethorpe
Fort Caswell
Fort McPherson
Augusta Arsenal
Fort Moultrie
Fort Sumter
Fort Barrancas
Fort Pickens
Fort Gaines
Fort Morgan
Fort McRee
Fort Clark
Fort Sam Houston
San Antonio Arsenal
Fort Travis
Fort San Jacinto
Fort Crockett
Jackson Bks
Fort Johnson
Fort St. Philip
Fort McIntosh
Fort Dade
Key West Bks
Fort Taylor
Presidio of San Francisco
Fort Miley
Fort Mason
Fort Baker
Fort Winfield Scott
Alcatraz Island
Benicia Arsenal
Mare Island
Angel Island
Fort McDowell
Fort Rosecrans
Fort Stanford
Fort Point
Fort Casey
Fort Worden
Fort Flagler
Fort Lawton
Fort Columbia
Fort Canby
Fort Stevens
Vancouver Barracks
Boise Bks
Presidio of Monterey
Sequoia
Yosemite
PORTLAND HARBOR
Forts Levett, McKinley, Preble, Williams
BOSTON HARBOR
Forts Foster, Constitution & Stark
Forts Heath, Banks, Strong, Standish, Andrews, Moss
NARRAGANSETT BAY
Forts Adams, Greble, Wetherill, Getty & Phillip Kearny, R I
Warren, Revere &
ENTRANCE TO LONG ISLAND SOUND
Forts Mansfield, R I., H C Wright, Michie
Terry & Tyler, N Y
NEW YORK HARBOR
Forts Slocum, Schuyler, Tollen Wood, Governors I., Jay and New York Arsenal, Hamilton & Wadsworth
N Y Sandy Hook Proving Gr & Ft Hancock, N J.
BALTIMORE HARBOR
Forts Mc Henry, Carroll, Armistead, Howard & Smallwood Md
POTOMAC RIVER
Forts Myer & Hunt Va Washington, Md
Washington Barracks D C
40°
45°
50°
55°
60°
65°
70°
30°
35°

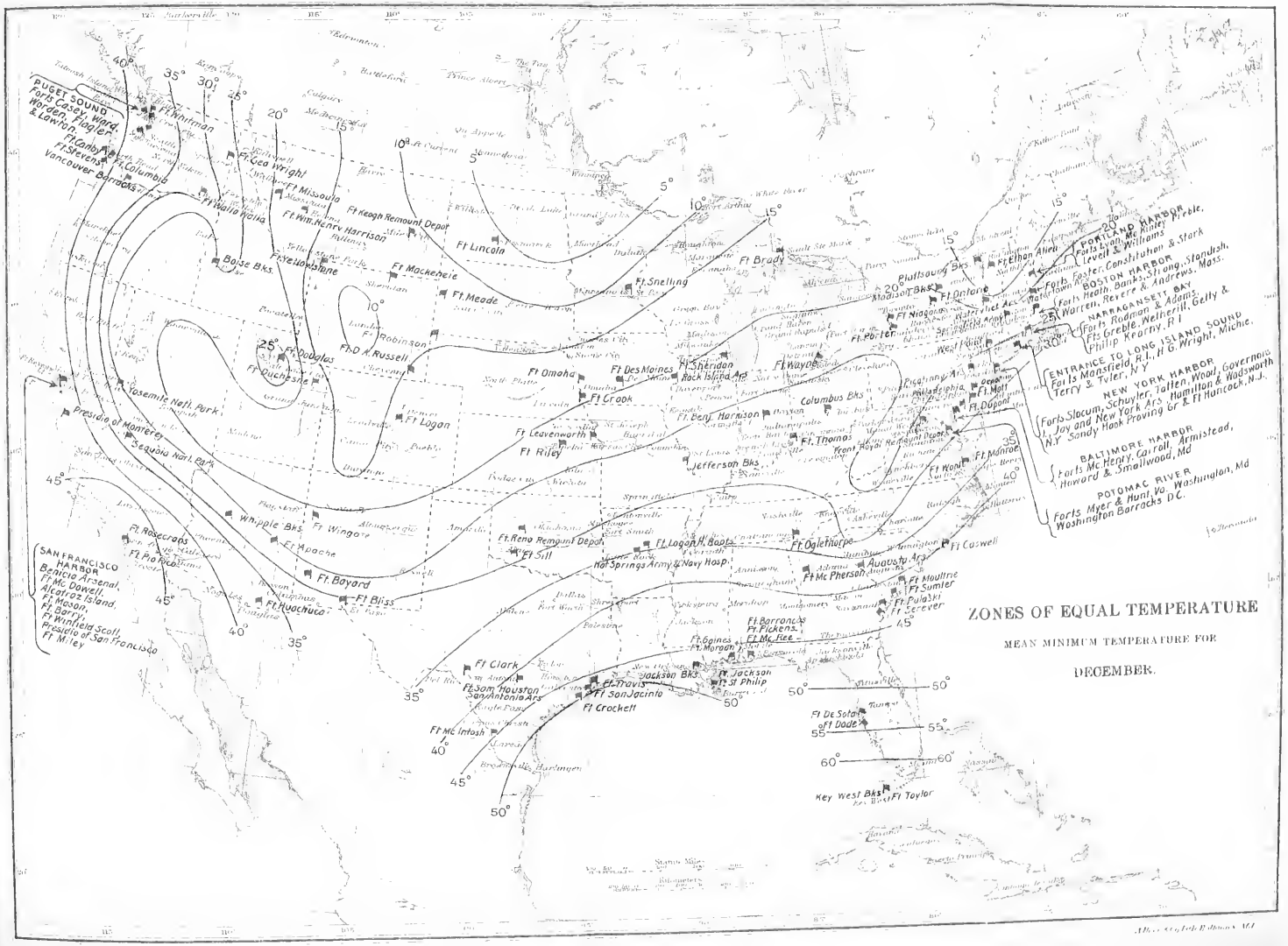


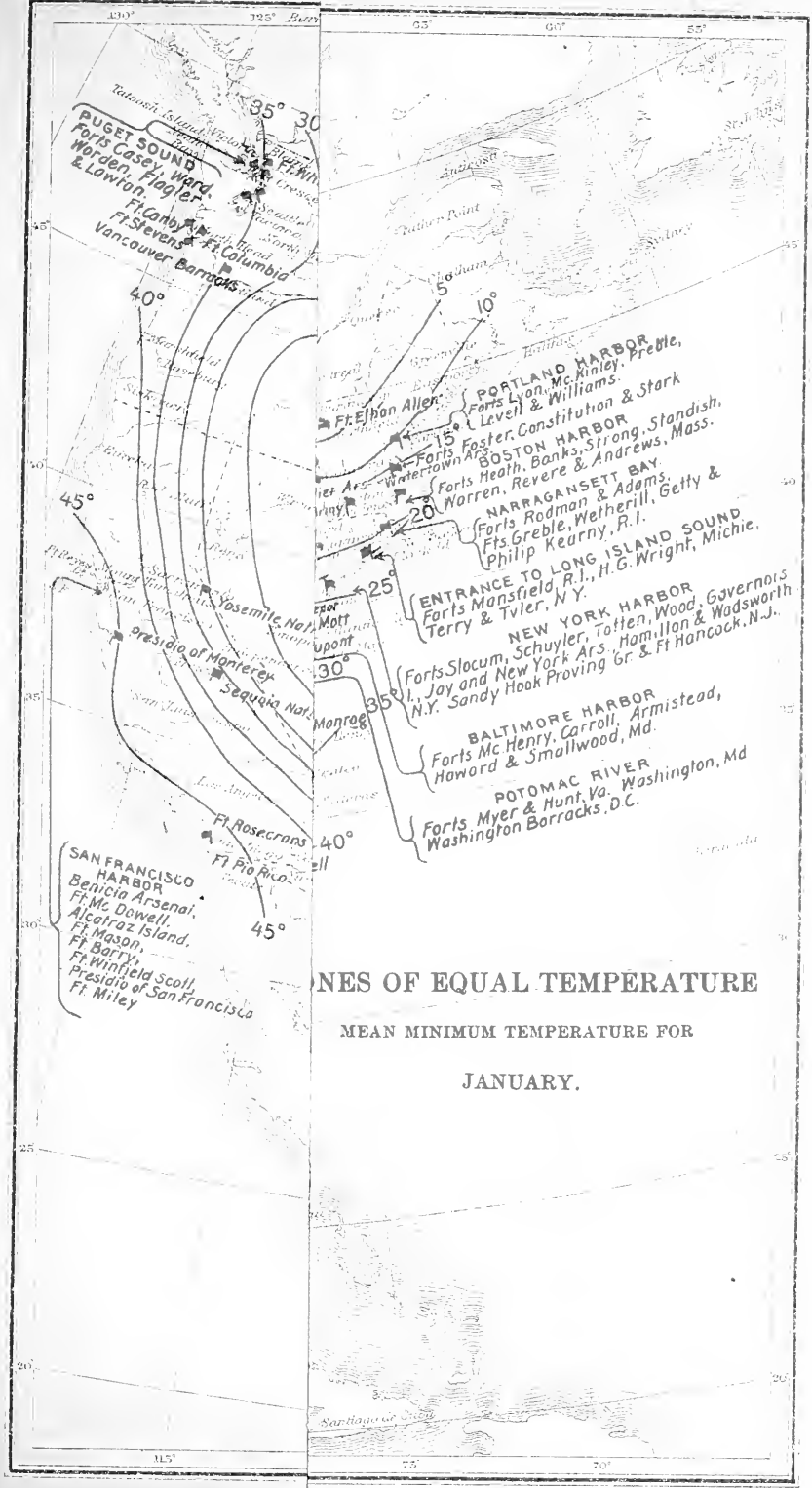
NES OF EQUAL TEMPERATURE

MEAN MINIMUM TEMPERATURE FOR

DECEMBER.

A. Hoen & Co. Lith. Baltimore, Md.

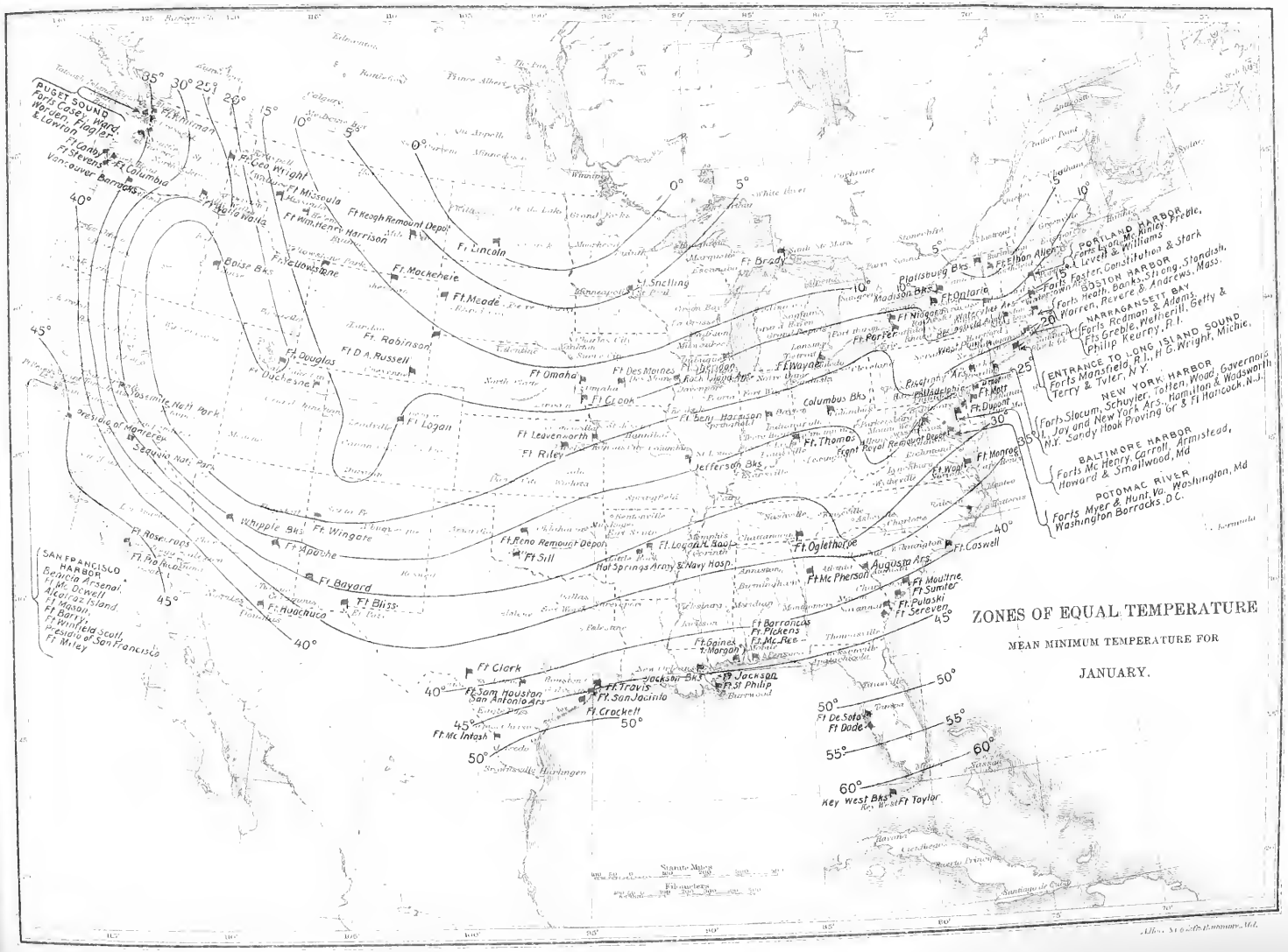

ZONES OF EQUAL TEMPERATURE
MEAN MINIMUM TEMPERATURE FOR
DECEMBER.
PUGET SOUND
Forts Casey, Ward, Worden, Flagler & Lawton
Ft Canby
Ft Columbia
Ft Stevens
Vancouver Barracks
Ft Whitman
Ft Walla Walla
Ft Geo Wright
Ft Missoula
Ft Wm Henry Harrison
Ft Keogh Remount Depot
Ft Lincoln
Ft Brady
Ft Snelling
Boise Bks
Ft Yellowstone
Ft Mackenzie
Ft Meade
Ft Robinson
Ft D A Russell
Ft Douglas
Ft Duchesne
Yosemite Natl Park
Presidio of Monterey
Sequoia Natl Park
Ft Logan
Ft Omaha
Ft Des Moines
Ft Sheridan
Rock Island Ars
Ft Wayne
Ft Crook
Ft Leavenworth
Ft Riley
Ft Benj Harrison
Columbus Bks
Ft Thomas
Jefferson Bks
Ft Whipple
Ft Wingate
Ft Apache
Ft Bayard
Ft Huachuca
Ft Bliss
Ft Rosecrans
Ft Rio Vista
SAN FRANCISCO HARBOR
Benicia Arsenal
Ft Mc Dowell
Alcatraz Island
Ft Mason
Ft Barry
Ft Winfield Scott
Presidio of San Francisco
Ft Miley
Ft Reno Remount Depot
Ft Sill
Ft Logan H Roots
Hot Springs Army & Navy Hosp
Ft Oglethorpe
Ft Caswell
Ft Mc Pherson
Augusta Ars
Ft Moultrie
Ft Sumter
Ft Pulaski
Ft Screven
Ft Barrancas
Ft Pickens
Ft Mc Ree
Ft Gaines
Ft Morgan
Ft Clark
Ft Sam Houston
San Antonio Ars
Ft Travis
Ft San Jacinto
Ft Crockett
Jackson Bks
Ft Jackson
Ft St Philip
Ft Mc Intosh
Ft De Soto
Ft Dade
Key West Bks
Ft Taylor
Plattsburg Bks
Ft Ontario
Ft Niagara
Ft Porter
West Point
Ft Hamilton
Ft Wadsworth
Ft Monroe
Ft Wool
Ft Dupont
Ft Mott
Ft Delaware
Ft Washington
Ft Foote
Ft Hunt
Ft Myer
Washington Barracks D.C.
PORTLAND HARBOR
Forts Preble, Mc Kinley, Lyon, Levett & Williams
BOSTON HARBOR
Forts Foster, Constitution & Stark
Forts Heath, Banks, Strong, Standish, Warren, Rexere & Andrews, Mass.
NARRAGANSETT BAY
Forts Rodman & Adams
Ft Greble, Wetherill, Getty & Phillip Kearny, R I
ENTRANCE TO LONG ISLAND SOUND
Fort Is Mansfield, R.I., H G Wright, Michie, Terry & Tyler, N Y
NEW YORK HARBOR
Forts Slocum, Schuyler, Totten, Wood, Governors I., Jay and New York Ars, Hamilton & Wadsworth N.Y. Sandy Hook Proving Gr & Ft Hancock, N.J.
BALTIMORE HARBOR
Forts Mc Henry, Carroll, Armistead, Howard & Smallwood, Md
POTOMAC RIVER

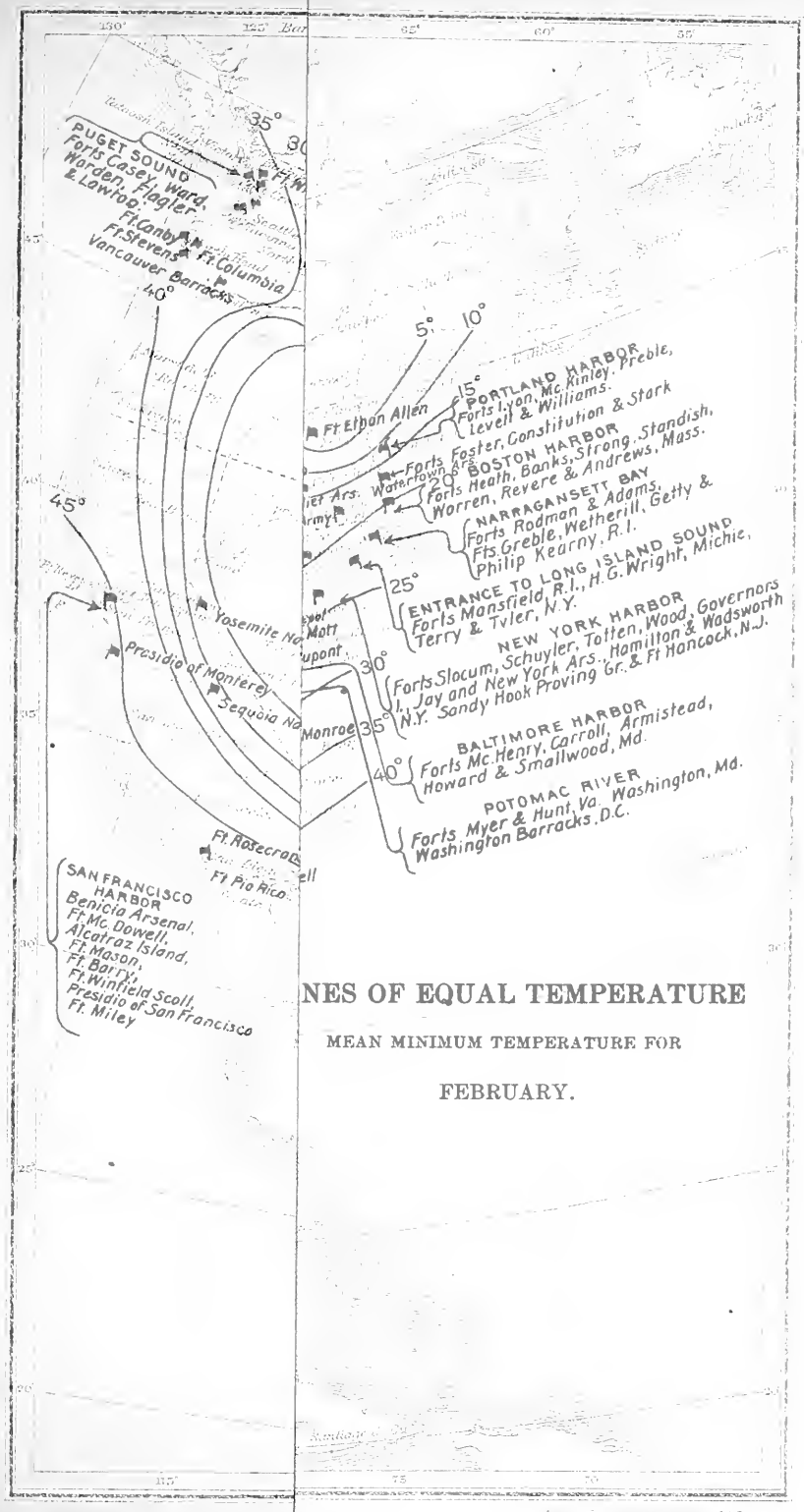


NES OF EQUAL TEMPERATURE

MEAN MINIMUM TEMPERATURE FOR

JANUARY.

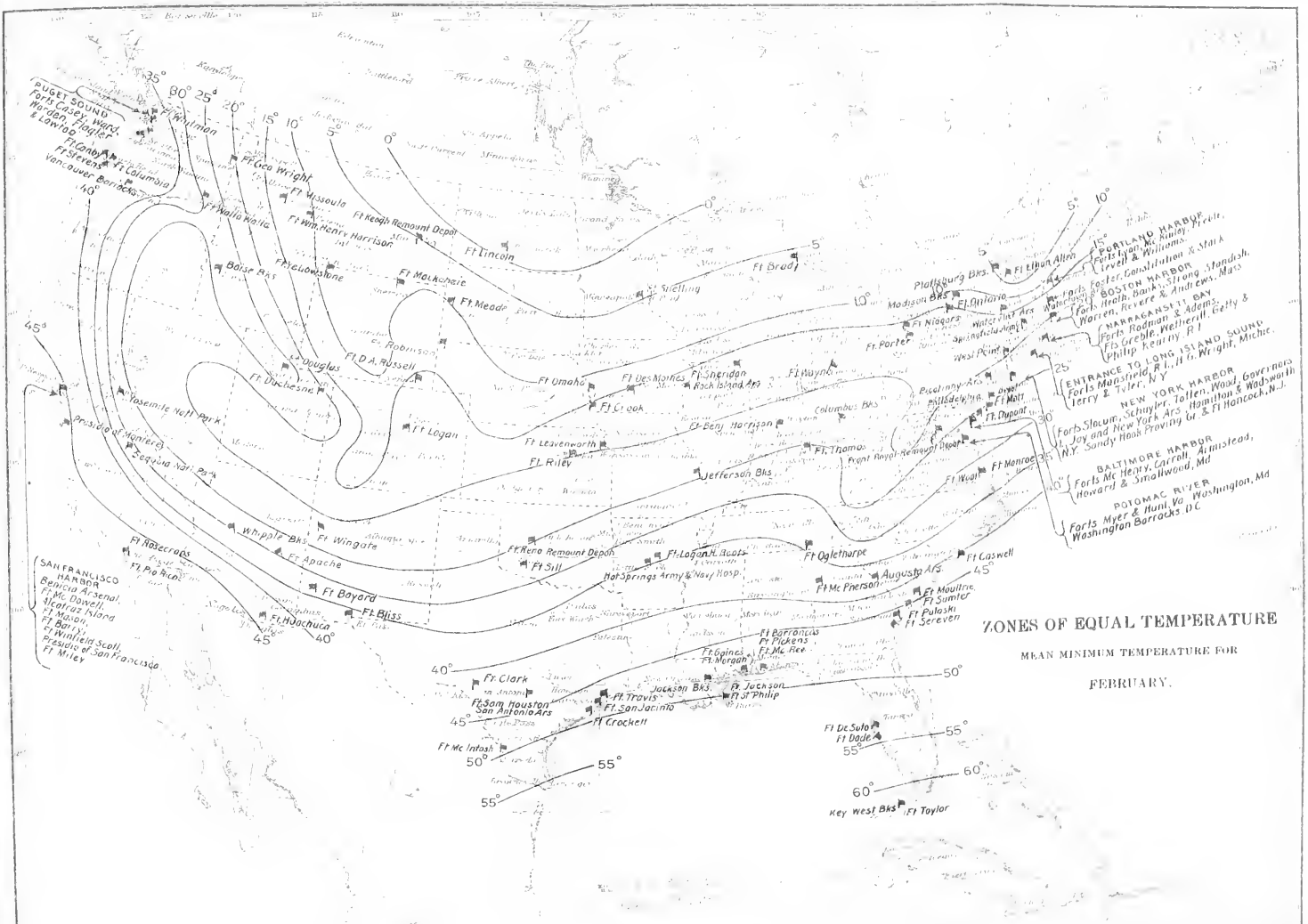

ZONES OF EQUAL TEMPERATURE
MEAN MINIMUM TEMPERATURE FOR
JANUARY.
PUGET SOUND
Forts Casey, Flagler, Worden, Ward, & Lawton
Ft Townsend
Ft Canby
Ft Columbia
Ft Stevens
Vancouver Barracks
Ft Walla Walla
Ft Cœur d'Alene
Ft Missoula
Ft Keogh Remount Depot
Ft Wm. Henry Harrison
Ft Lincoln
Ft Snelling
Ft Brady
Boise Brks
Ft Custer
Ft Mackenzie
Ft Meade
Ft Robinson
Ft Douglas
Ft D. A. Russell
Ft Duchesne
Ft Omaha
Ft Des Moines
Ft Dodge
Ft Wayne
Ft Cook
Ft Logan
Ft Leavenworth
Ft Riley
Columbus Brks
Ft Thomas
Front Royal Remount Depot
Jefferson Brks
Yosemite Nat. Park
Presidio of Monterey
Sequoia Nat. Park
Whipple Brks
Ft Wingate
Ft Apache
Ft Reno Remount Depot
Ft Sill
Ft Bayard
Ft Huachuca
Ft Bliss
Ft Rosecrans
Ft Point
SAN FRANCISCO HARBOR
Benicia Arsenal
Ft Mc Dowell
Alcatraz Island
Ft Mason
Ft Barry
Ft Winfield Scott
Presidio of San Francisco
Ft Miley
Ft Clark
Ft Sam Houston
San Antonio Arsenal
Ft San Jacinto
Ft Travis
Ft Crockett
Ft Mc Intosh
Jackson Brks
Ft Jackson
Ft St Philip
Ft Barrancas
Ft Pickens
Ft Mc Ree
Ft Gaines
Ft Morgan
Hot Springs Army & Navy Hosp.
Ft Logan H. Roots
Ft Oglethorpe
Augusta Arsenal
Ft Mc Pherson
Ft Moultrie
Ft Sumter
Ft Pulaski
Ft Screven
Ft Coswell
Ft De Soto
Ft Dade
Key West Brks
Ft Taylor
Plattsburg Brks
Madison Brks
Ft Ontario
Ft Niagara
Ft Porter
Ft Wayne
Ft Hamilton
Ft Wadsworth
Ft Slocum
Ft Schuyler
Ft Totten
Ft Wood
Ft Hancock
Ft Monroe
Ft Dupont
Ft Mott
Ft Delaware
Ft Washington
PORTLAND HARBOR
Forts Preble, Mc Kinley & Levett & Williams
BOSTON HARBOR
Forts Faster, Constitution & Stark
Forts Heath, Banks, Strong, Standish, Warren, Revere & Andrews, Mass.
NARRAGANSETT BAY
Forts Redman & Adams
Forts Greble, Wetherill, Getty & Philip Kearny, R.I.
ENTRANCE TO LONG ISLAND SOUND
Forts Mansfield, R.I., H.G. Wright, Michie, Terry & Tyler, N.Y.
NEW YORK HARBOR
Forts Slocum, Schuyler, Totten, Wood, Governors I., Jay and New York Ars., Hamilton & Wadsworth N.Y. Sandy Hook Proving Gr. & Ft Hancock, N.J.
BALTIMORE HARBOR
Forts Mc Henry, Carroll, Armistead, Howard & Smallwood, Md
POTOMAC RIVER
Forts Myer & Hunt, Va. Washington, Md
Washington Barracks, D.C.
Bermuda
Nassau
Havana
Santiago de Cuba
Key West
Tortugas
Statute Miles
Nautical Miles
Kilometers

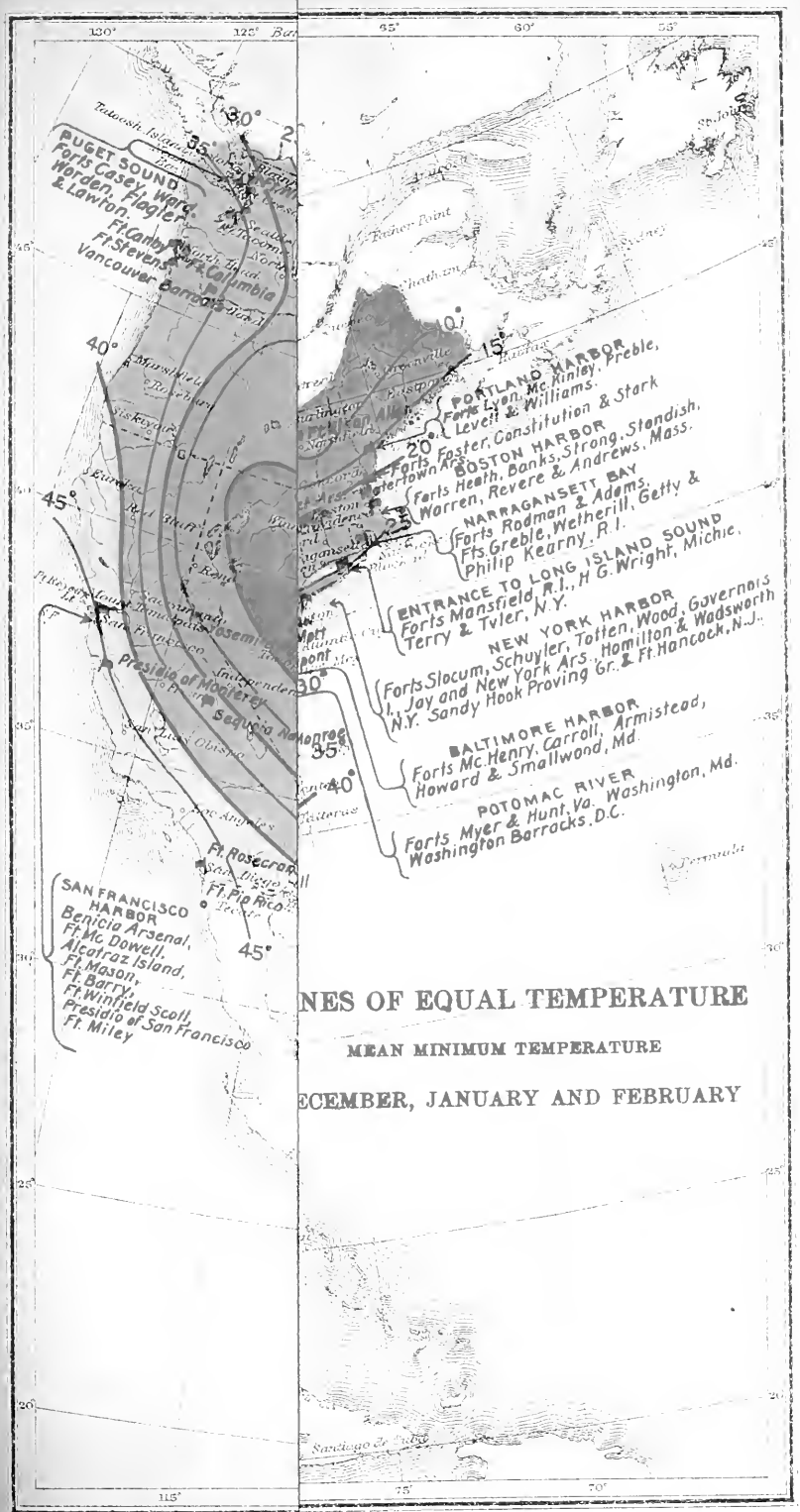


NES OF EQUAL TEMPERATURE

MEAN MINIMUM TEMPERATURE FOR

FEBRUARY.

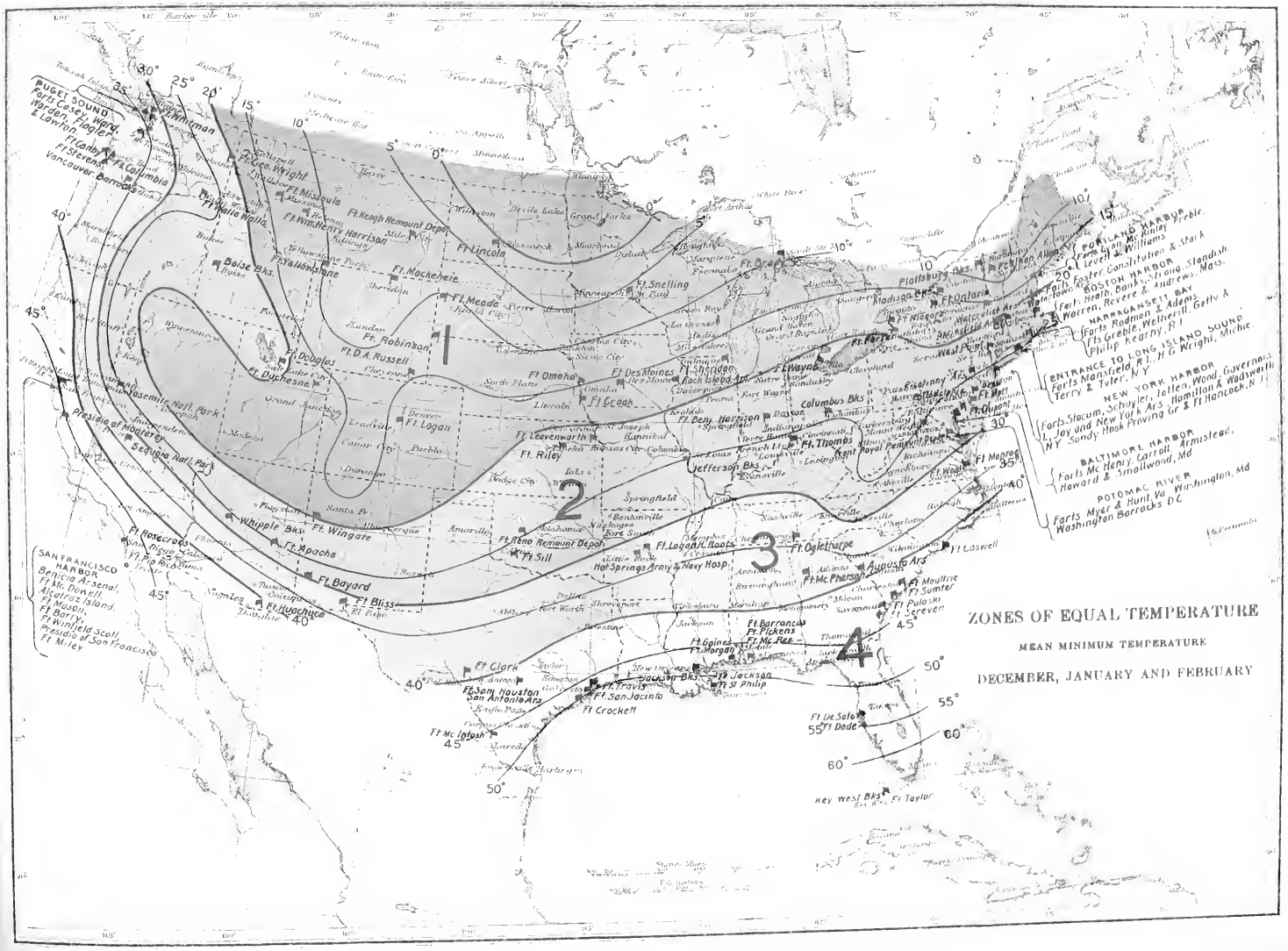

PUGET SOUND
Fort Casey, Ft. Ward,
Fort Worden, Ft. Flagler
& Lowndes
Ft. Canby
Ft. Stevens
Vancouver Barracks
Ft. Columbia
Ft. Whitman
Ft. Walla Walla
Ft. Coeur d'Alene
Ft. Missoula
Ft. Wm. Henry Harrison
Ft. Keogh Remount Depot
Ft. Lincoln
Ft. Yellowstone
Boise Bks
Ft. Custer
Ft. Meade
Ft. Robinson
Ft. D. A. Russell
Ft. Douglas
Ft. Duchesne
Ft. Omaha
Ft. Des Moines
Ft. Sheridan
Rock Island Ars
Ft. Wayne
Ft. Crook
Ft. Logan
Ft. Leavenworth
Ft. Riley
Jefferson Bks
Ft. Thomas
Front Royal Remount Depot
Ft. Myer
Ft. Monroe
Yosemite Nat'l Park
Presidio of Monterey
Sequoia Nat'l Park
Whipple Bks
Ft. Wingate
Ft. Rosecrans
Ft. Rio Vista
Ft. Apache
Ft. Bayard
Ft. Bliss
Ft. Huachuca
Ft. Reno Remount Depot
Ft. Sill
Ft. Logan H. Roots
Hot Springs Army & Navy Hosp.
Ft. Oglethorpe
Ft. Caswell
Ft. McPherson
Augusta Ars
Ft. Moultrie
Ft. Sumter
Ft. Pulaski
Ft. Screven
SAN FRANCISCO HARBOR
Benicia Arsenal
Ft. McDowell
Alcatraz Island
Ft. Mason
Ft. Baker
Ft. Winfield Scott
Presidio of San Francisco
Ft. Miley
Ft. Barrancas
Ft. Pickens
Ft. Gaines
Ft. Morgan
Ft. Mc Rae
Ft. Clark
Ft. Sam Houston
San Antonio Ars
Jackson Bks
Ft. Jackson
Ft. St. Philip
Ft. Travis
Ft. San Jacinto
Ft. Crockett
Ft. Mc Intosh
Ft. De Soto
Ft. Dade
Key West Bks
Ft. Taylor
Plattsburg Bks.
Ft. Ethan Allen
Madison Bks
Ft. Ontario
Ft. Niagara
Ft. Porter
West Point
Watervliet Ars
Springfield Armory
PORTLAND HARBOR
Forts Levett, Mc Kinley,
Preble, Williams &
Scammel
BOSTON HARBOR
Forts Foster, Constitution & Stark
Forts Heath, Banks, Strong, Standish,
Warren, Revere & Andrews, Mass
NARRAGANSETT BAY
Forts Rodman & Adams,
Ft. Greble, Wetherill, Getty &
Philip Kearny, R.I.
ENTRANCE TO LONG ISLAND SOUND
Forts Mansfield, R.I. & Wright, Michie,
Terry & Tyler, N.Y.
NEW YORK HARBOR
Forts Slocum, Schuyler, Totten, Wood, Governors
I., Hay and New York Ars., Hamilton & Wadsworth
N.Y. Sandy Hook Proving Gr. & Ft. Hancock, N.J.
BALTIMORE HARBOR
Forts Mc Henry, Carroll, Armistead,
Howard & Smallwood, Md
POTOMAC RIVER
Forts Myer & Hunt, Va. Washington, Md
Washington Barracks, DC
ZONES OF EQUAL TEMPERATURE
MEAN MINIMUM TEMPERATURE FOR
FEBRUARY.

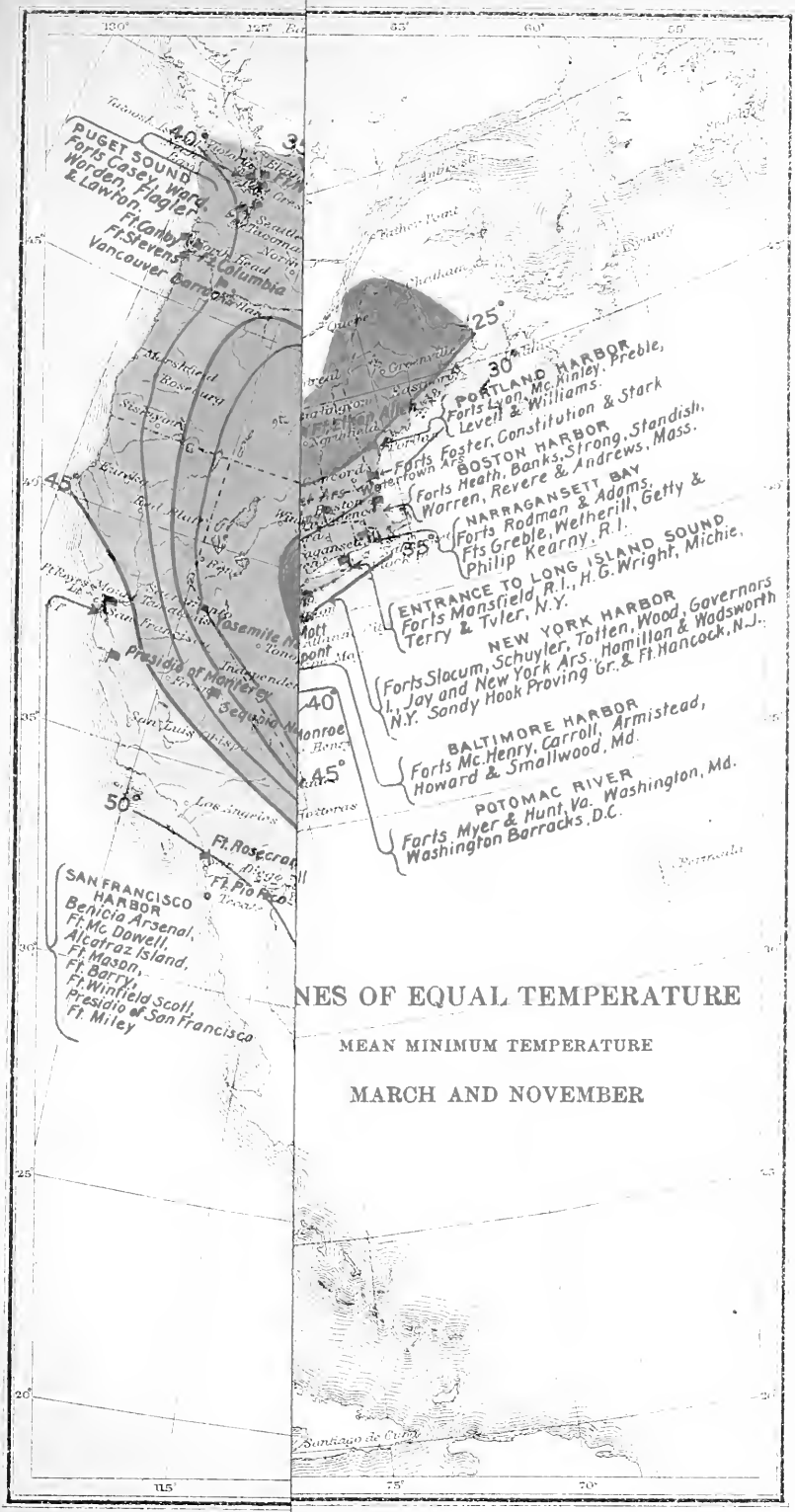


NES OF EQUAL TEMPERATURE

MEAN MINIMUM TEMPERATURE

ECEMBER, JANUARY AND FEBRUARY

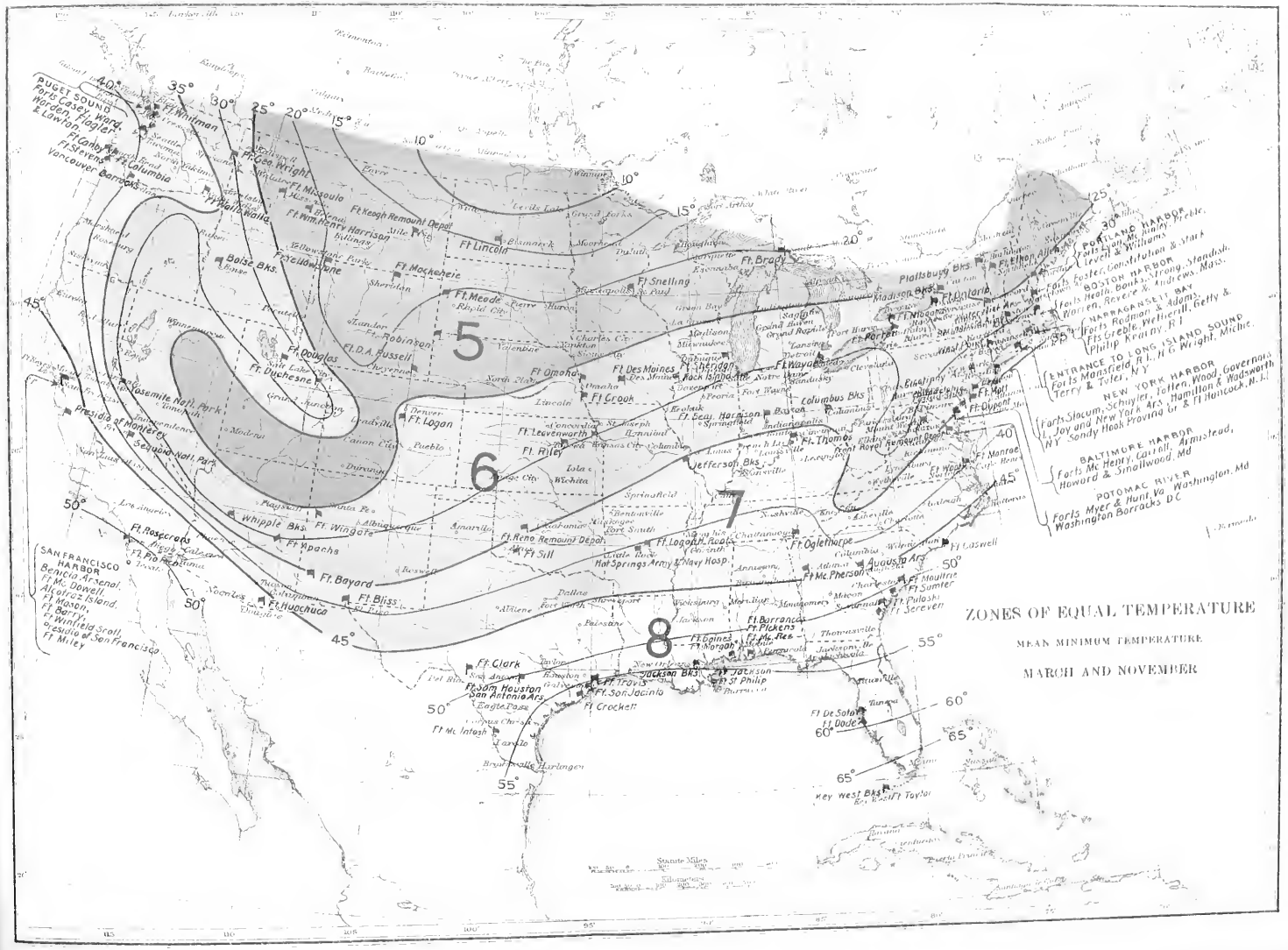

ZONES OF EQUAL TEMPERATURE
MEAN MINIMUM TEMPERATURE
DECEMBER, JANUARY AND FEBRUARY
1
2
3
4
PUGET SOUND
Forts Casey, Ward, Worden, Flagler & Lawton
Ft Whitman
Ft Columbia
Ft Stanley
Ft Stevens
Vancouver Barracks
Ft Geo Wright
Ft Walla Walla
Ft Missoula
Ft Keogh Remount Depot
Ft Wm Harrison
Ft Lincoln
Ft Yellowstone
Boise Bks
Ft Mackenzie
Ft Meade
Ft Robinson
Ft Douglas
Ft D A Russell
Ft Duchesne
Yosemite Nat'l Park
Presidio of Monterey
Sequoia Nat'l Park
Ft Logan
Ft Leavenworth
Ft Riley
Ft Omaha
Ft Des Moines
Ft Crook
Ft Sheridan
Ft Wayne
Ft Porter
Ft Niagara
Ft Ontario
Plattsburg Bks
Ft Snelling
Ft Brady
Ft Wilkins
Ft Trumbull
Ft Adams
Ft Constitution
Ft Stark
Ft Foster
Ft Heath
Ft Revere
Ft Andrews
Ft Standish
Ft Rodman
Ft Greble
Ft Wetherill
Ft Getty
Ft Hearny
Ft Terry
Ft Mansfield
Ft H G Wright
Ft Schuyler
Ft Wood
Ft Hamilton
Ft Wadsworth
Ft Hancock
Ft Slocum
Ft Jay
Ft Lafayette
Ft Columbus
Ft Thomas
Ft Clark
Ft Sam Houston
San Antonio Arsenal
Ft Travis
Ft San Jacinto
Ft Crockett
Jackson Bks
Ft Jackson
Ft St Philip
Ft Barrancas
Ft Pickens
Ft Mc Rae
Ft Ogelthorpe
Augusta Arsenal
Ft Mc Pherson
Ft Moultrie
Ft Sumter
Ft Pulaski
Ft Screven
Ft De Soto
Ft Dade
Key West Bks
Ft Taylor
Ft Whipple
Ft Wingate
Ft Apache
Ft Bayard
Ft Bliss
Ft Huachuca
Ft Rosecrans
Ft Mc Dowell
Ft Winfield Scott
Presidio of San Francisco
Ft Miley
Ft Sill
Ft Reno Remount Depot
Hot Springs Army & Navy Hosp
Ft Logan H Roots
Jefferson Bks
Columbus Bks
Ft Monroe
Ft Myer
Ft Washington
Ft Foote
Ft Carroll
Ft Armistead
Ft Howard
Ft Smallwood
Ft Myer
Ft Hunt
Washington Barracks
PORTLAND HARBOR
BOSTON HARBOR
NARRAGANSET BAY
LONG ISLAND SOUND
ENTRANCE TO
NEW YORK HARBOR
BALTIMORE HARBOR
POTOMAC RIVER
SAN FRANCISCO HARBOR

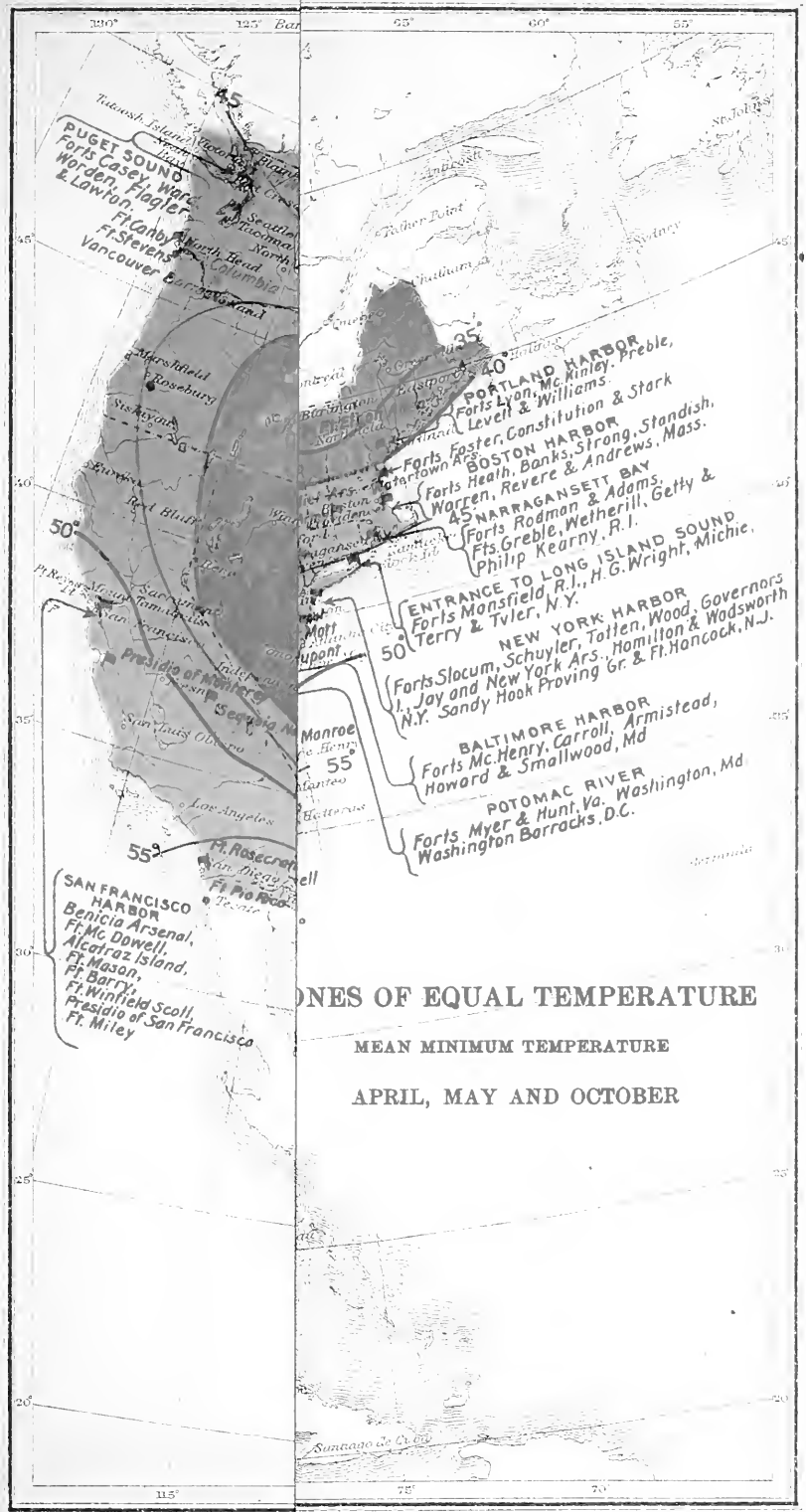


NES OF EQUAL TEMPERATURE

MEAN MINIMUM TEMPERATURE

MARCH AND NOVEMBER

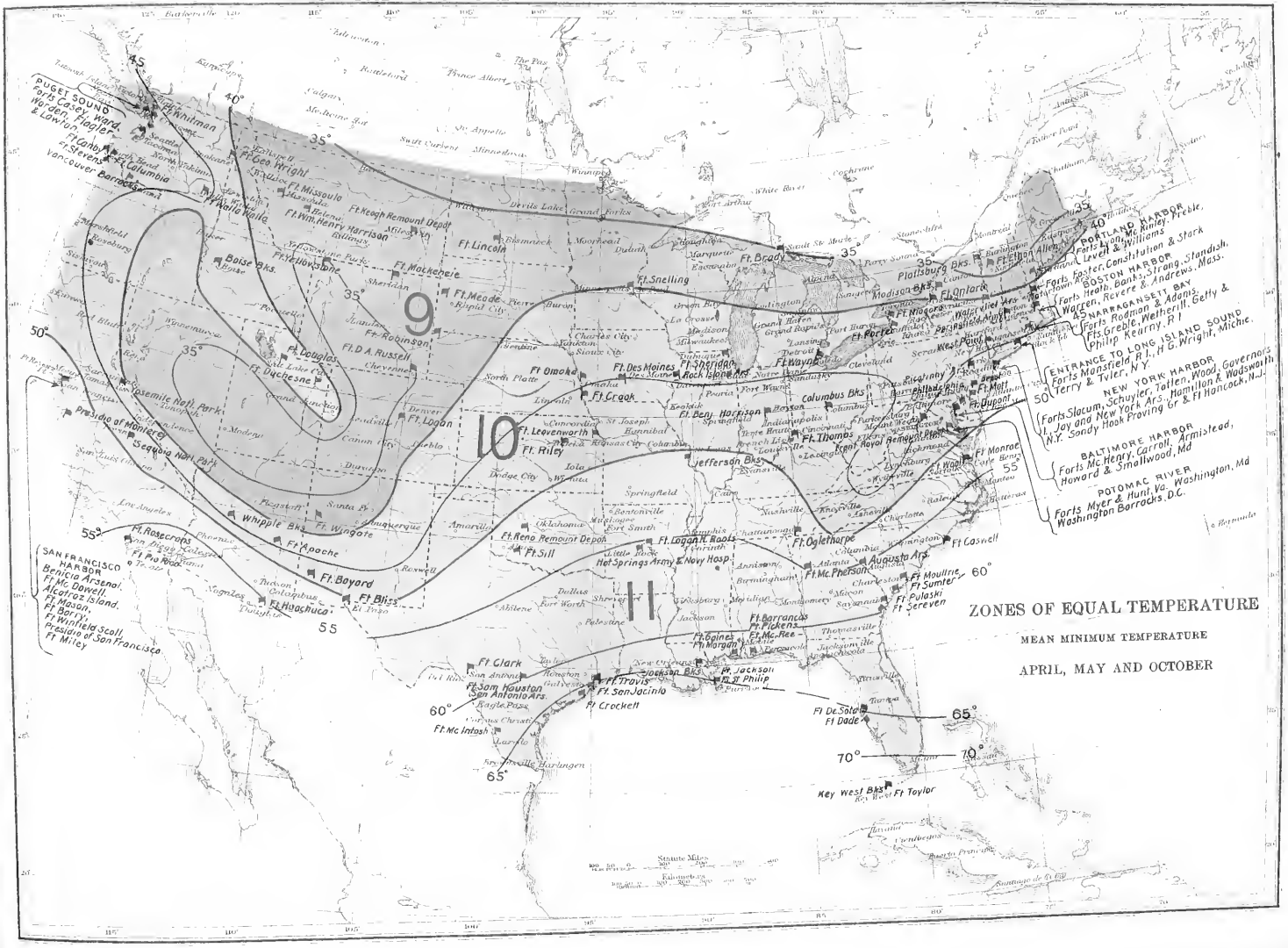

ZONES OF EQUAL TEMPERATURE
MEAN MINIMUM TEMPERATURE
MARCH AND NOVEMBER
5
6
7
8
PUGET SOUND
Forts Casey, Ward, Worden, Flagler & Lawton
Ft Columbia
Ft Canby
Ft Stevens
Vancouver Barracks
Ft Whitman
Ft Wright
Ft Missoula
Ft Wm Henry Harrison
Ft Keogh Remount Depot
Ft Lincoln
Ft Mackenzie
Boise Bks
Yellowstone Park
Ft Meade
Ft Robinson
Ft D A Russell
Ft Douglas
Ft Duchesne
Yosemite Nat'l Park
Presidio of Monterey
Sequoia Nat'l Park
Ft Logan
Ft Riley
Ft Leavenworth
Ft Omaha
Ft Des Moines
Ft Crook
Ft Meyer
Ft Whipple
Ft Wingate
Ft Apache
Ft Rosecrans
Ft Rio Vista
SAN FRANCISCO HARBOR
Benicia Arsenal
Ft McDowell
Alcatraz Island
Ft Mason
Ft Barry
Ft Winfield Scott
Presidio of San Francisco
Ft Miley
Ft Bayard
Ft Bliss
Ft Huachuca
Ft Reno Remount Depot
Ft Sill
Ft Logan H Roots
Hot Springs Army & Navy Hosp
Ft Oglethorpe
Ft Barrancas
Ft Pickens
Ft Mc Rae
Ft Gaines
Ft Morgan
Ft Clark
Ft Travis
Jackson Bks
Ft Jackson
Ft St Philip
Ft Sam Houston
San Antonio Arsenal
Ft San Jacinto
Ft Crockett
Ft McIntosh
Ft De Soto
Ft Dade
Key West Bks
Ft Taylor
Ft Ontario
Plattsburg Bks
Madison Bks
Ft Niagara
Ft Porter
Ft Hancock
Ft Hamilton
Ft Wadsworth
Ft Slocum
Ft Schuyler
Ft Hancock
Columbus Bks
Ft Thomas
Ft Dupont
Ft Monroe
Ft Washington
Ft Caswell
Augusta Arsenal
Ft Mc Pherson
Ft Moultrie
Ft Sumter
Ft Pulaski
Ft Screven
PORTLAND HARBOR
Forts Williams, Mc Kinley, Levett & Williams
BOSTON HARBOR
Forts Foster, Constitution & Stark
Forts Heath, Banks, Strong, Standish, Warren, Revere & Andrews, Mass.
NARRAGANSETT BAY
Forts Rodman & Adams
Forts Greble, Wetherill, Getty & Phillip Kearny, R I
ENTRANCE TO LONG ISLAND SOUND
Forts Mansfield, R I, H G Wright, Michie, Terry & Totten, N Y
Forts Slocum, Schuyler, Totten, Wood, Governors I, Jay and New York Arsenal, Hamilton & Wadsworth
Sandy Hook Proving Gr & Ft Hancock, N J
BALTIMORE HARBOR
Forts Mc Henry, Carroll, Armistead, Howard & Smallwood, Md
POTOMAC RIVER
Forts Myer & Hunt, Va Washington, Md
Washington Barracks D C
Statute Miles

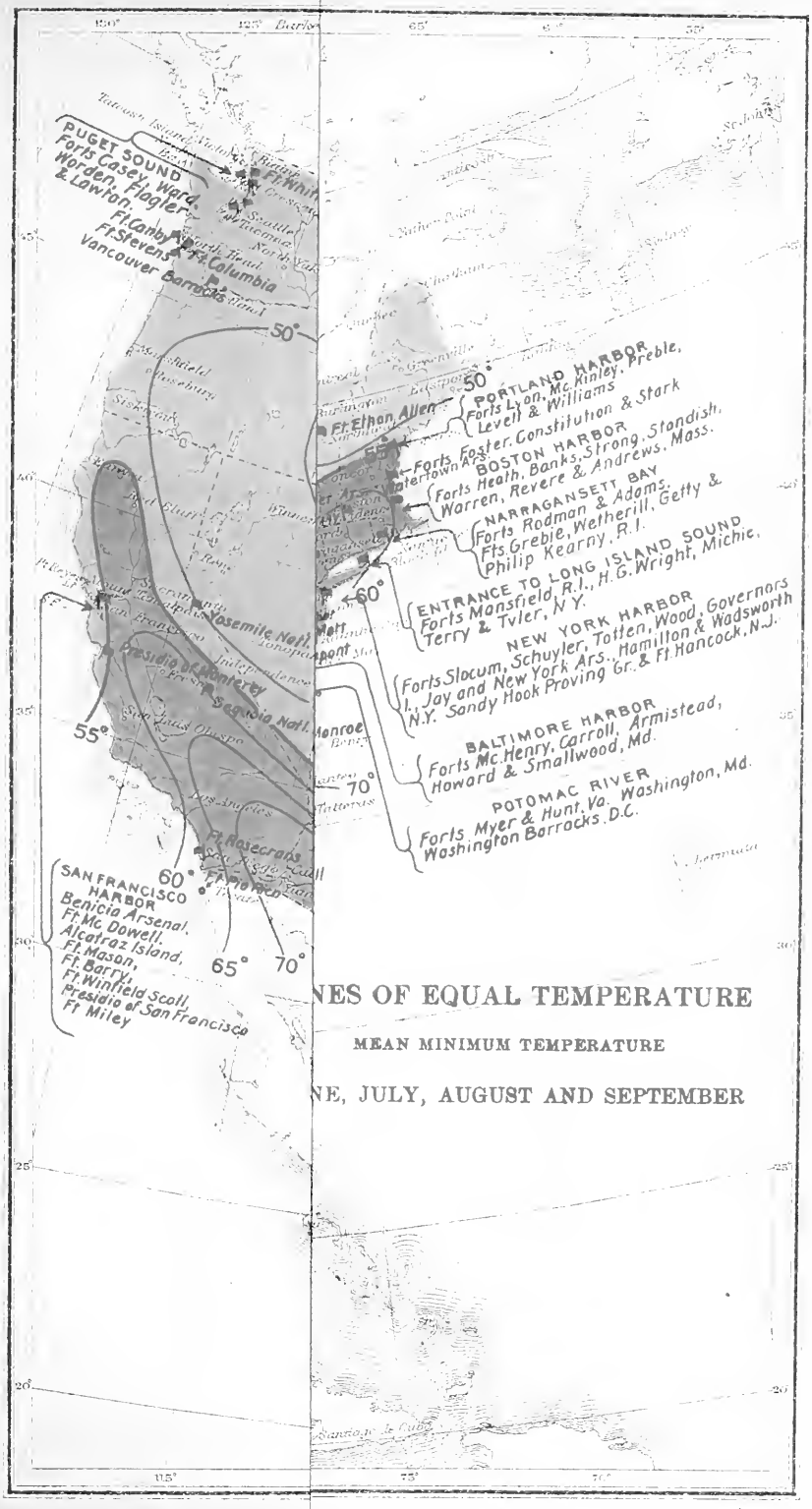


ONES OF EQUAL TEMPERATURE

MEAN MINIMUM TEMPERATURE

APRIL, MAY AND OCTOBER

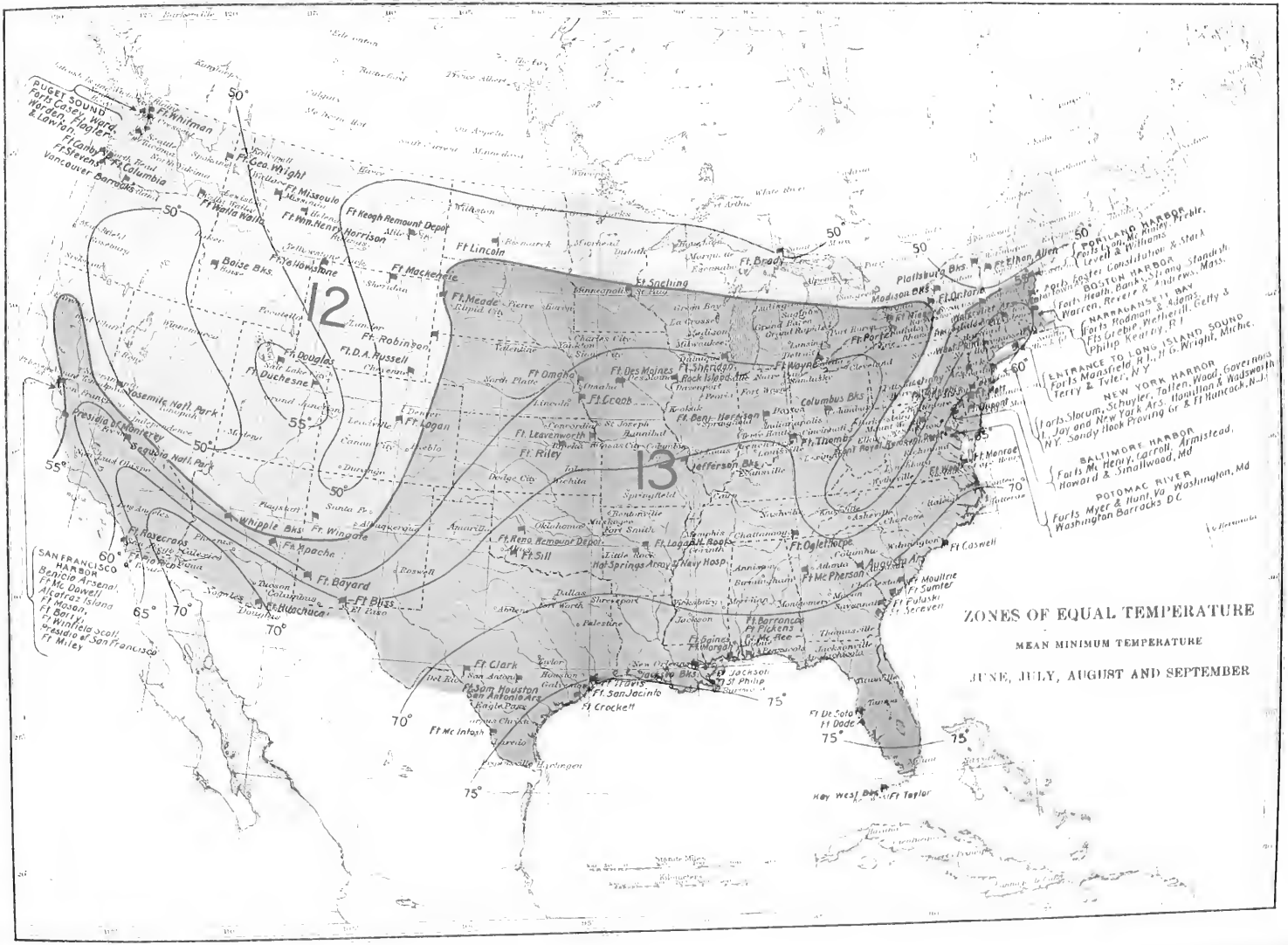

ZONES OF EQUAL TEMPERATURE
MEAN MINIMUM TEMPERATURE
APRIL, MAY AND OCTOBER
9
10
11
PUGET SOUND
Forts Casey, Ward, Worden, Flagler & Lawton
Ft Whitman
Ft Columbia
Ft Stevens
Vancouver Barracks
Ft Walla Walla
Ft Geo Wright
Ft Missoula
Ft Keogh Remount Depot
Ft Wm Henry Harrison
Ft Lincoln
Ft Yellowstone
Ft Mackenzie
Boise Brks
Ft Meade
Ft Robinson
Ft D A Russell
Ft Douglas
Ft Duchesne
Yosemite Natl Park
Presidio of Monterey
Sequoia Natl Park
Ft Logan
Ft Leavenworth
Ft Riley
Ft Omaha
Ft Crook
Ft Des Moines
Ft Sheridan
Rock Island Arst
Ft Snelling
Ft Brady
Ft Wayne
Ft Porter
Ft Niagara
Ft Ontario
Plattsburg Brks
Madison Brks
Watervliet Arsn
Sackets Harbor
Plattsburg Brks
Ft Preble
Ft Constitution
Ft Stark
Ft Foster
Ft Greble
Ft Kearny
Ft Wright
Ft Michie
Ft Hancock
Ft Wadsworth
Ft Hamilton
Ft Schuyler
Ft Slocum
Ft Jay
Ft Monroe
Ft Mott
Ft Dupont
Columbus Brks
Ft Ben Harrison
Ft Thomas
Jefferson Brks
Ft Logan H Roots
Ft Reno Remount Depot
Ft Sill
Hot Springs Army & Navy Hosp
Ft Whipple
Ft Wingate
Ft Apache
Ft Rosecrans
Ft Mc Dowell
Ft Bayard
Ft Huachuca
Ft Bliss
Whipple Brks
SAN FRANCISCO HARBOR
Benicia Arsenal
Ft Mc Dowell
Alcatraz Island
Ft Mason
Ft Barry
Ft Winfield Scott
Presidio of San Francisco
Ft Miley
Ft Clark
Ft Sam Houston
Ft Travis
Ft San Jacinto
Ft Crockett
Ft Mc Intosh
Ft Jackson
Ft Philip
Jackson Brks
Ft Barrancas
Ft Pickens
Ft Mc Ree
Ft Gaines
Ft Morgan
Ft De Soto
Ft Dade
Key West Brks
Ft Taylor
Augusta Arst
Ft Mc Pherson
Ft Oglethorpe
Ft Caswell
Ft Moultrie
Ft Sumter
Ft Pulaski
Ft Screven
PORTLAND HARBOR
Forts Levett, Mc Kinley, Preble, Lyon & Williams
BOSTON HARBOR
Forts Foster, Constitution & Stark
Forts Heath, Banks, Strong, Standish
Warren, Revere & Andrews, Mass.
NARRAGANSETT BAY
Forts Adams, Wetherill, Getty & Greble
Ft Kearny, R I
Philip
ENTRANCE TO LONG ISLAND SOUND
Forts Mansfield, R I
Terry & Tyler, N Y
NEW YORK HARBOR
Forts Schuyler, Tatten, Wood, Governors
Jay and New York Arsenal, Hamilton & Wadsworth
Sandy Hook Proving Gr & Ft Hancock, N J
BALTIMORE HARBOR
Forts Mc Henry, Carroll, Armistead,
Howard & Smallwood, Md
POTOMAC RIVER
Forts Myer & Hunt, Va
Washington Barracks, D C
Statute Miles

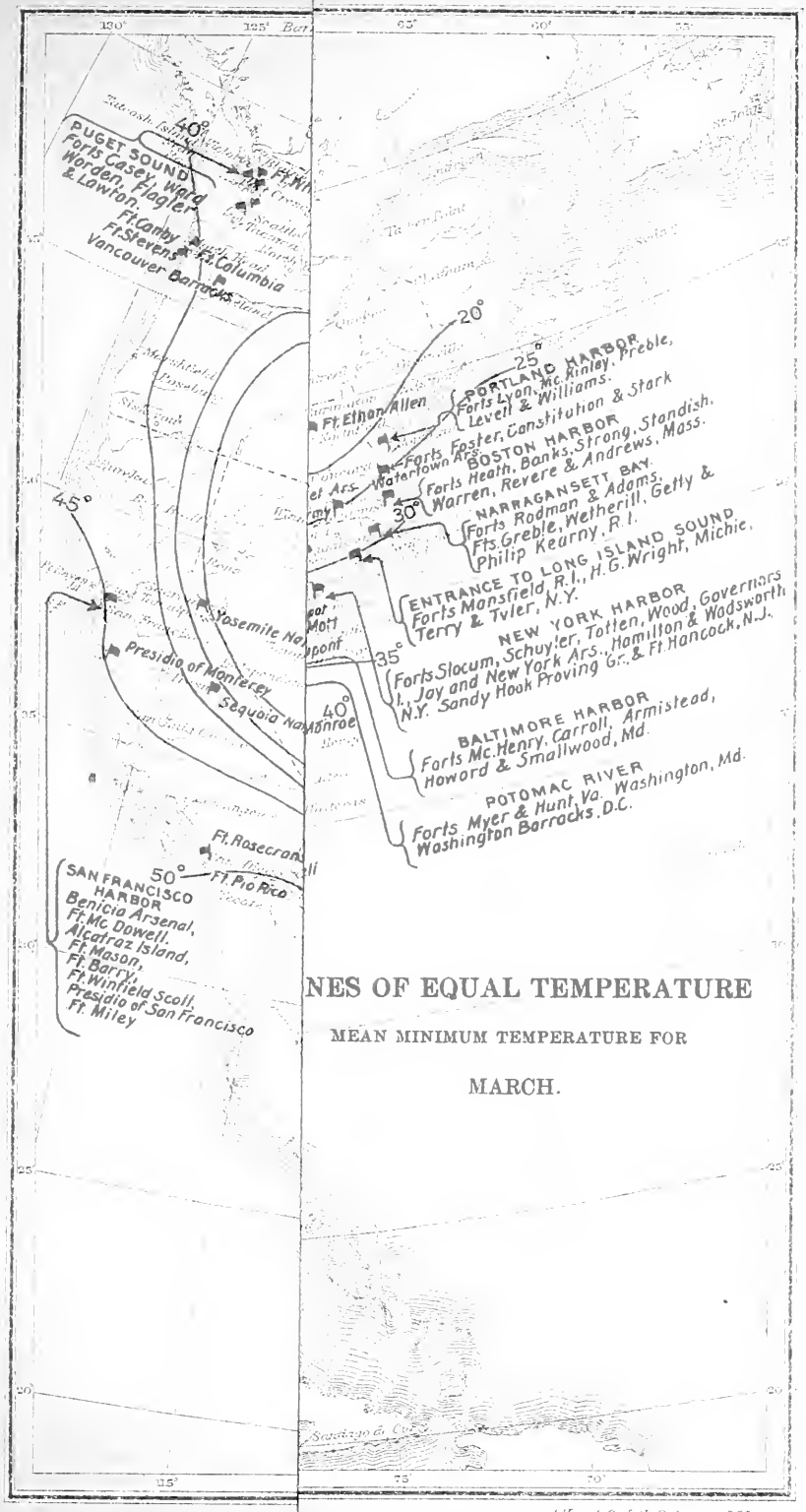


NES OF EQUAL TEMPERATURE

MEAN MINIMUM TEMPERATURE

NE, JULY, AUGUST AND SEPTEMBER


ZONES OF EQUAL TEMPERATURE
MEAN MINIMUM TEMPERATURE
JUNE, JULY, AUGUST AND SEPTEMBER
12
13
PUGET SOUND
Forts Casey, Flagler, Warden, & Lawton
Ft Whitman
Ft Columbia
Ft Canby
Ft Stevens
Vancouver Barracks
Ft Geo. Wright
Ft Missoula
Ft Wallula
Ft Wm. Henry Harrison
Ft Keogh Remount Depot
Ft Lincoln
Ft Yellowstone
Boise Brks.
Ft Mackenzie
Ft Meade
Ft Robinson
Ft D.A. Russell
Ft Douglas
Ft Duchesne
Yosemite Natl. Park
Presidio of Monterey
Sequoia Natl. Park
Ft Logan
Ft Omaha
Ft Des Moines
Ft Sheridan
Ft Sneliing
Ft Brady
Ft Leavenworth
Ft Riley
Ft Reno Remount Depot
Ft Sill
Ft Logan H. Roots
Navy Hosp
Jefferson Brks
Ft Whipple
Ft Wingate
Ft Apache
Ft Bayard
Ft Bliss
Ft Huachuca
Ft Rosecrans
SAN FRANCISCO HARBOR
Benicia Arsenal
Ft Mc Dowell
Alcatraz Island
Ft Mason
Ft Barry
Ft Winfield Scott
Presidio of San Francisco
Ft Miley
Ft Clark
Ft Sam Houston
Ft Mc Intosh
Ft San Jacinto
Ft Crockett
Ft Brown
Ft Jackson
Ft Pulaski
Ft Sumter
Ft Moultrie
Ft Casweil
Ft Oglethorpe
Ft Mc Pherson
Augusta Arsl
Ft Barrancas
Ft Pickens
Ft Mc Rae
Ft Eagles
Ft Morgan
Key West Brks
Ft Taylor
Ft De Soto
Ft Dade
Ft Ontario
Madison Brks
Plattsburg Brks
Ft Ethan Allen
Ft Porter
Ft Hancock
PORTLAND HARBOR
Forts Scammel, Preble, Levett & Williams
Forts Foster Constitution & Stark
BOSTON HARBOR
Forts Standish, Strong, Warren, Revere & Andrews, Mass.
NARRAGANSETT BAY
Forts Heath, Bank, Adams, Wetherill, Getty & Greble, Wright, Michie.
ENTRANCE TO LONG ISLAND SOUND
Forts Mansfield, R.I., Terry & Tyler, N.Y.
NEW YORK HARBOR
Forts Slocum, Tallen, Wood, Gover nors I. Jay and New York Brks, Hamilton & Hudswoth N.Y. Sandy Hook Proving Gr. & Ft Hancock, N.J.
BALTIMORE HARBOR
Forts Mc Henry, Carroll, Armistead, Howard & Smallwood, Md
POTOMAC RIVER
Forts Myer & Hunt, Va Washington, Md
Washington Barracks D.C.
50°
55°
60°
65°
70°
75°

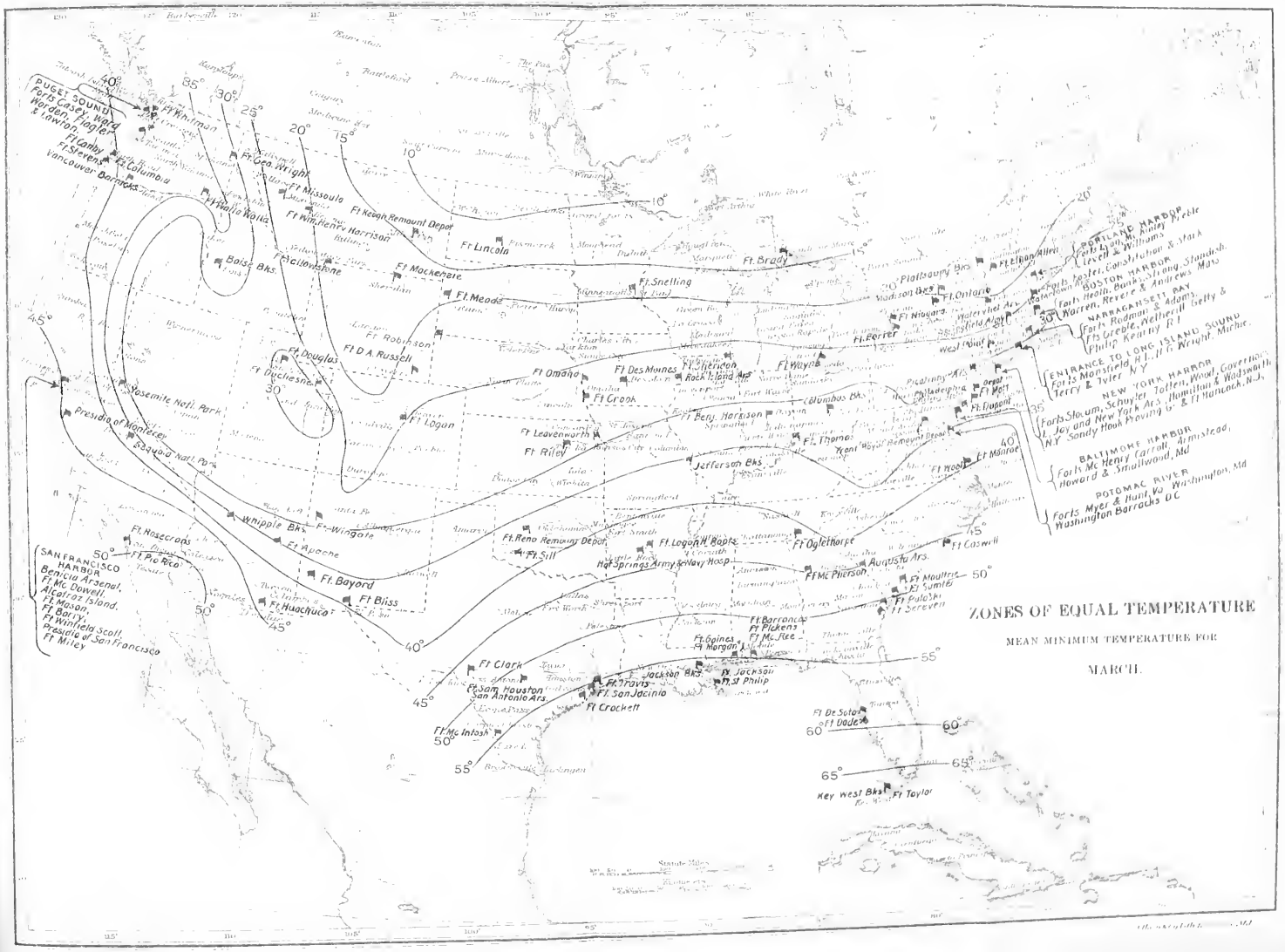


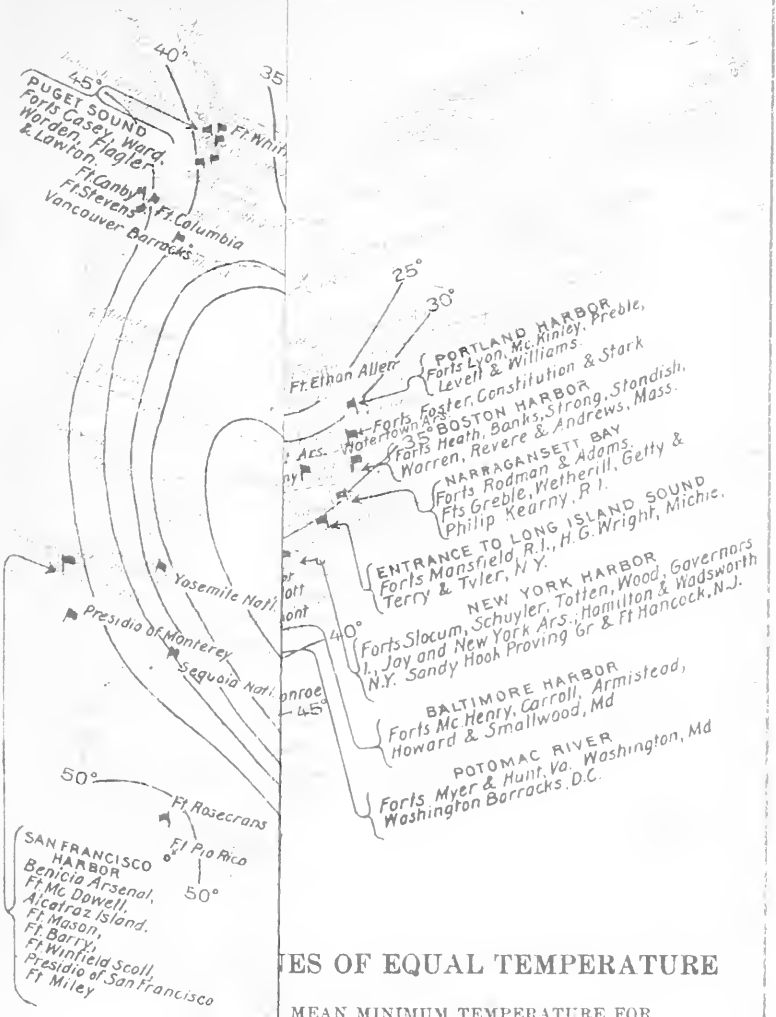
NES OF EQUAL TEMPERATURE

MEAN MINIMUM TEMPERATURE FOR

MARCH.

A. Hoen & Co. Lith. Baltimore, Md.

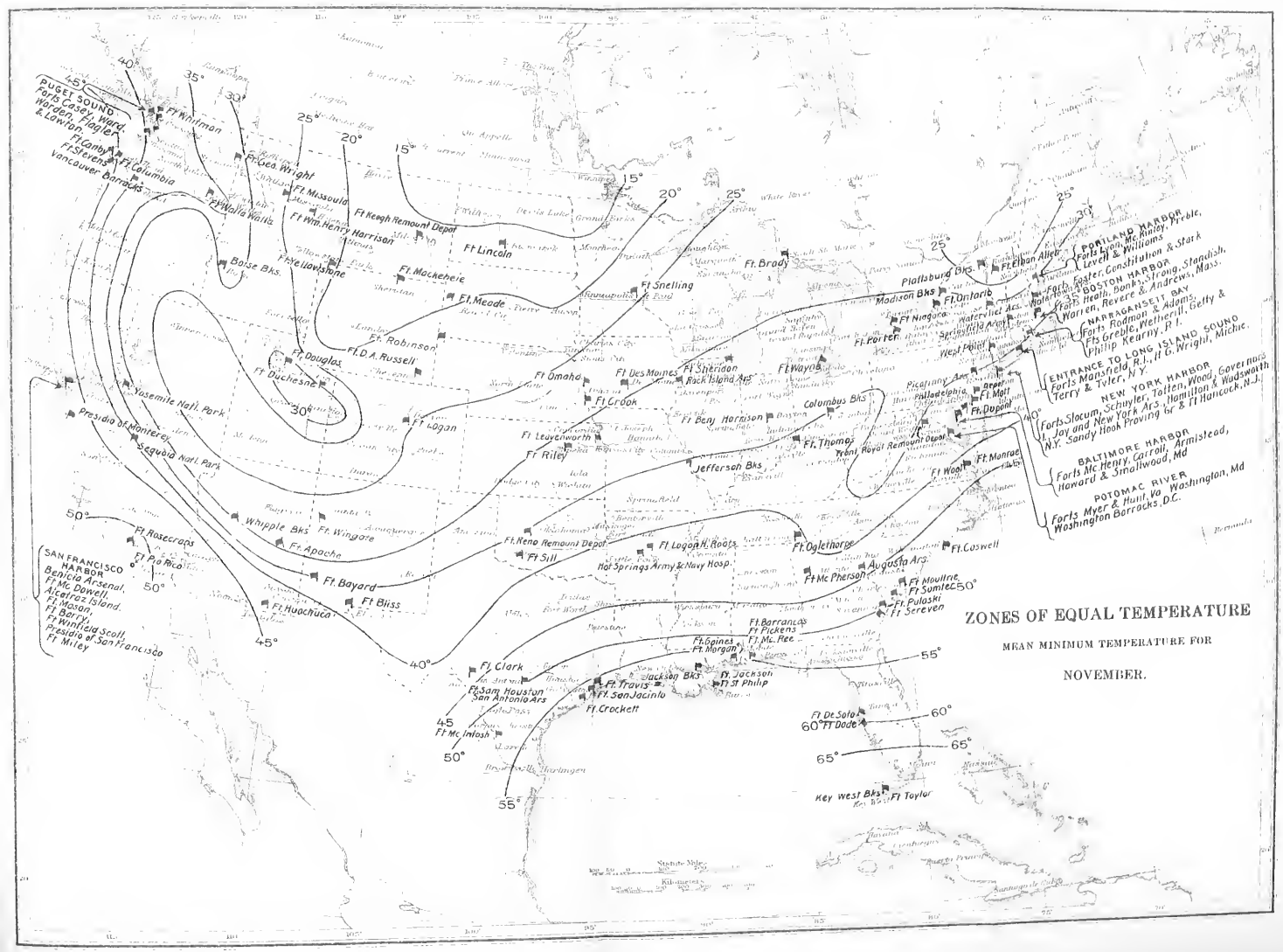

ZONES OF EQUAL TEMPERATURE
MEAN MINIMUM TEMPERATURE FOR
MARCH.
PUGET SOUND
Forts Casey, Ward
Worden, Flagler
Lawton
Ft Canby
Ft Steven
Vancouver Barracks
Ft Columbia
Ft Walla Walla
Ft Wright
Ft Geo Wright
Ft Missoula
Ft Wm Henry Harrison
Ft Keogh Remount Depot
Ft Lincoln
Ft Brady
Boise Brks
Ft Sherman
Ft Mackenzie
Ft Meade
Ft Snelling
Ft Robinson
Ft D A Russell
Ft Douglas
Ft Duchesne
Yosemite Natl Park
Presidio of Monterey
Sequoia Natl Park
Ft Logan
Ft Omaha
Ft Des Moines
Ft Sheridan
Rock Island Ars
Ft Wayne
Ft Crook
Ft Leavenworth
Ft Riley
Ft Benj Harrison
Jefferson Brks
Ft Thomas
Ft Porter
Ft Niagara
Ft Ontario
Plattsburg Brks
Madison Brks
Ft Ethan Allen
Ft Preble
Ft Levett
Ft Williams
PORTLAND HARBOR
Forts Scammel & Mark
Forts Foster, Constitution & Stark
BOSTON HARBOR
Forts Heath, Banks, Strong, Standish
Fort Warren, Revere & Andrews Mass
NARRAGANSETT BAY
Forts Rodman, Adams
Fts Greble, Wetherill Getty &
Philip Kearny R I
ENTRANCE TO LONG ISLAND SOUND
Forts Mansfield, H L, Ft Wright, Michie
Terry & Tyler N Y
NEW YORK HARBOR
Forts Slocum, Schuyler, Totten, Wood, Cavenor
L Joy and New York Brks, Hamilton & Wadsworth
N Y Sandy Hook Proving G & Ft Hancock, N J
BALTIMORE HARBOR
Forts Mc Henry, Carroll, Armistead,
Howard & Smallwood, Md
POTOMAC RIVER
Forts Myer & Hunt, Va Washington, Md
Washington Barracks D C
Ft Monroe
Ft Wool
Ft Eustis
Ft Monroe Remount Depot
Ft Caswell
Ft Oglethorpe
Ft Logan H Roots
Hot Springs Army & Navy Hosp
Ft Reno Remount Depot
Ft Sill
Ft Whipple Brks
Ft Wingate
Ft Apache
Ft Bayard
Ft Bliss
Ft Huachuca
Ft Nosecrans
Ft Mc Rico
SAN FRANCISCO HARBOR
Benicia Arsenal,
Ft Mc Dowell,
Alcatraz Island,
Ft Mason,
Ft Barry,
Ft Winfield Scott,
Presidio of San Francisco
Ft Miley
Ft Mc Pherson
Augusta Brks
Ft Moultrie
Ft Sumter
Ft Sullivan
Ft Screven
Ft Barrancas
Ft Pickens
Ft Mc Ree
Ft Gaines
Ft Morgan
Ft Clark
Ft Sam Houston
San Antonio Brks
Jackson Brks
Ft Travis
Ft San Jacinto
Ft Crockett
St Jackson
St Philip
Ft Mc Intosh
Ft De Soto
Ft Dade
Key West Brks
Ft Taylor
Statute Miles

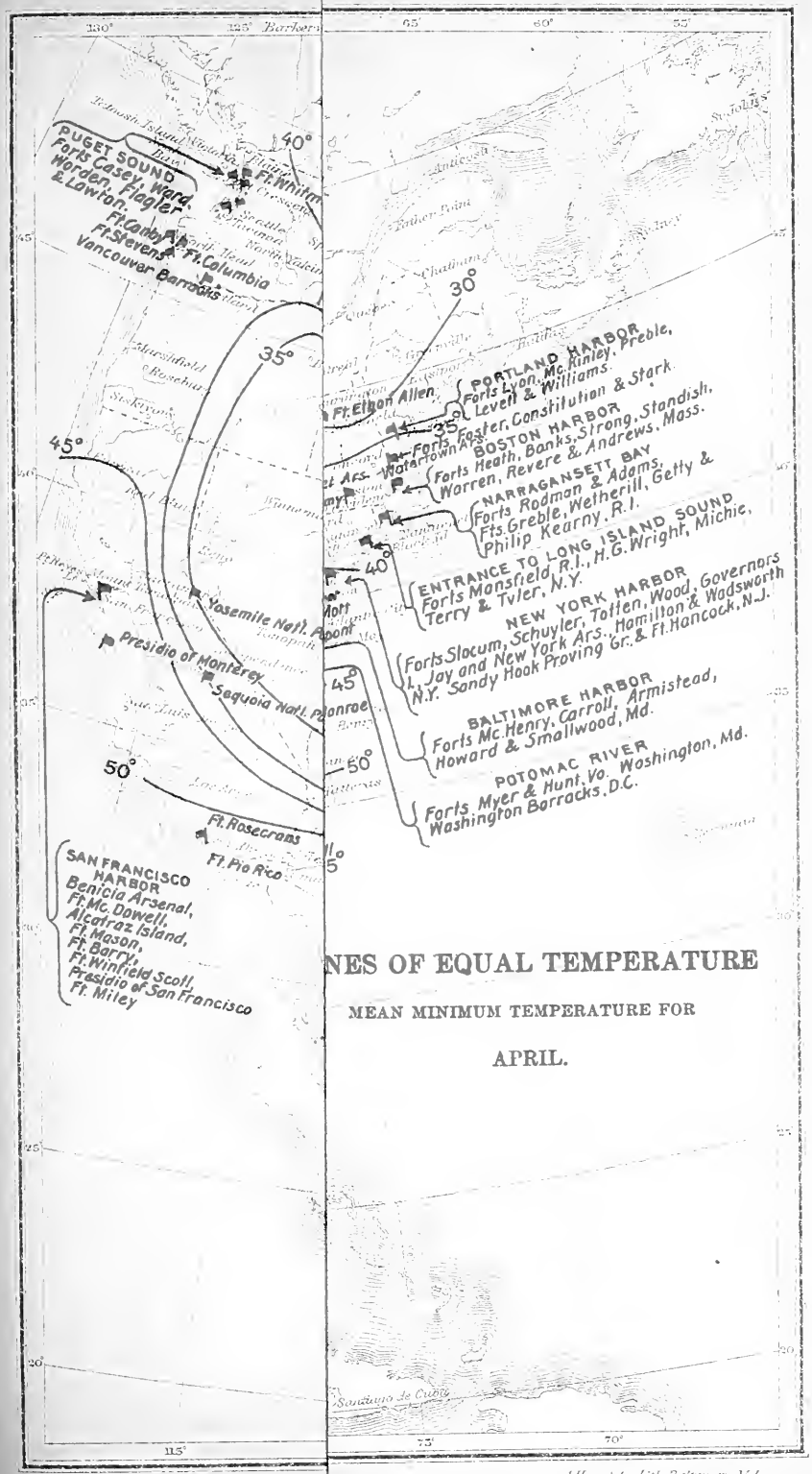


...ES OF EQUAL TEMPERATURE

MEAN MINIMUM TEMPERATURE FOR

NOVEMBER.

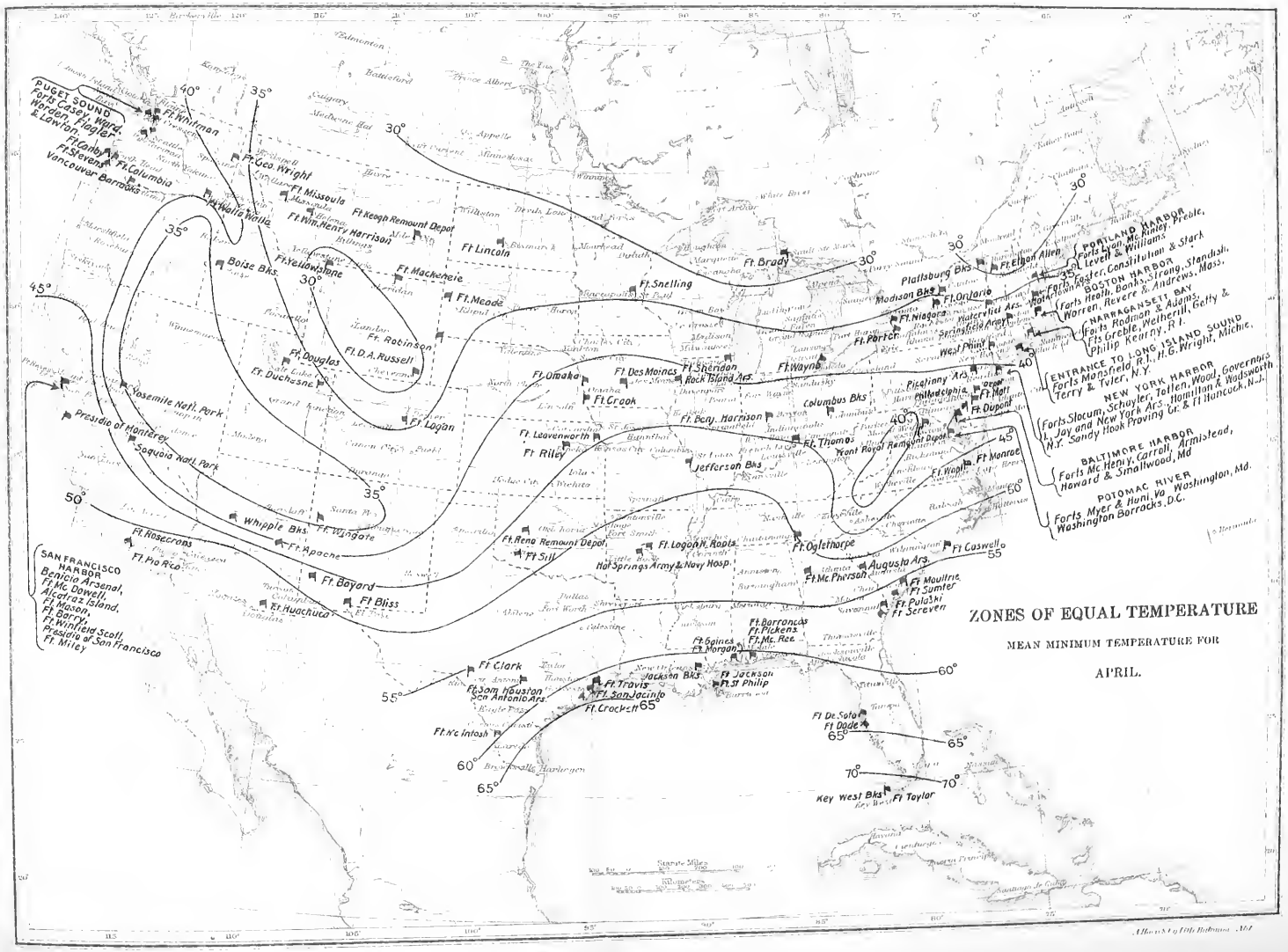

ZONES OF EQUAL TEMPERATURE
MEAN MINIMUM TEMPERATURE FOR
NOVEMBER.
PUGET SOUND
Forts Casey, Ward, Warden, Flagler & Lawton
Ft Whitman
Ft Lawton
Ft Columbia
Ft Stevens
Vancouver Barracks
Ft Walla Walla
Ft Geo. Wright
Ft Missoula
Ft Wm. Henry Harrison
Ft Keogh Remount Depot
Ft Lincoln
Boise Bks.
Ft Yellowstone
Ft Mackenzie
Ft Meade
Ft Robinson
Ft D. A. Russell
Ft Douglas
Ft Duchesne
Yosemite Natl. Park
Presidio of Monterey
Sequoia Natl. Park
Ft Logan
Ft Omaha
Ft Des Moines
Ft Sheridan
Rock Island Ars
Ft Crook
Ft Leavenworth
Ft Riley
Ft Benj. Harrison
Ft Thomas
Ft Wayne
Ft Snelling
Ft Brady
Jefferson Bks
Trenton Royal Remount Depot
Colombus Bks
Ft Rosecrans
Ft Mc Pherson
Ft Oglethorpe
Ft Coswell
Augusta Ars
Ft Moultrie
Ft Sumter
Ft Pulaski
Ft Screven
Ft Barrancas
Ft Pickens
Ft Mc. Rae
Ft Gaines
Ft Morgan
Ft Clark
Ft Sam Houston
San Antonio Ars
Ft Travis
Ft San Jacinto
Ft Crockett
Jackson Bks
Ft Jackson
Ft St Philip
Ft Mc Intosh
Ft De Soto
Ft Dade
Key West Bks
Ft Taylor
Ft Whipple
Bks
Ft Wingate
Ft Apache
Ft Bayard
Ft Huachuca
Ft Bliss
Ft Reno Remount Depot
Ft Logan H. Roots
Hot Springs Army & Navy Hosp.
Ft Sill
SAN FRANCISCO HARBOR
Benicia Arsenal
Ft Mc Dowell
Alcatraz Island
Ft Mason
Ft Barry
Ft Winfield Scott
Presidio of San Francisco
Ft Miley
Ft Ontario
Ft Niagara
Ft Porter
Ft Elbon Allen
Madison Bks
Plattsburg Bks.
Watervliet Arsenal
Springfield Arsenal
West Point
Ft Depot
Ft Mott
Ft Monroe
Ft Wool
Philadelphia
Upper Pisquinny Arsenal
PORTLAND HARBOR
Forts Mc Kinley, Preble, Levett & Williams
BOSTON HARBOR
Forts Foster, Constitution & Stark
Forts Heath, Banks, Strong, Standish, Warren, Revere & Andrews, Mass.
NARRAGANSETT BAY
Forts Rodman & Adams
Fts Greble, Wetherill, Getty & Philip Kearny, R. I.
ENTRANCE TO LONG ISLAND SOUND
Forts Mansfield, R. I. & G. Wright, Michie, Terry & Tyler, N. Y.
NEW YORK HARBOR
Forts Schuyler, Totten, Wood, Governors I. Jay and New York Ars. Hamilton & Wadsworth
N.Y. Sandy Hook Proving Gr. & Ft Hancock, N.J.
BALTIMORE HARBOR
Forts Mc Henry, Carroll, Armistead, Howard & Smallwood, Md
POTOMAC RIVER
Forts Myer & Hunt, Va Washington, Md
Washington Barracks, D.C.

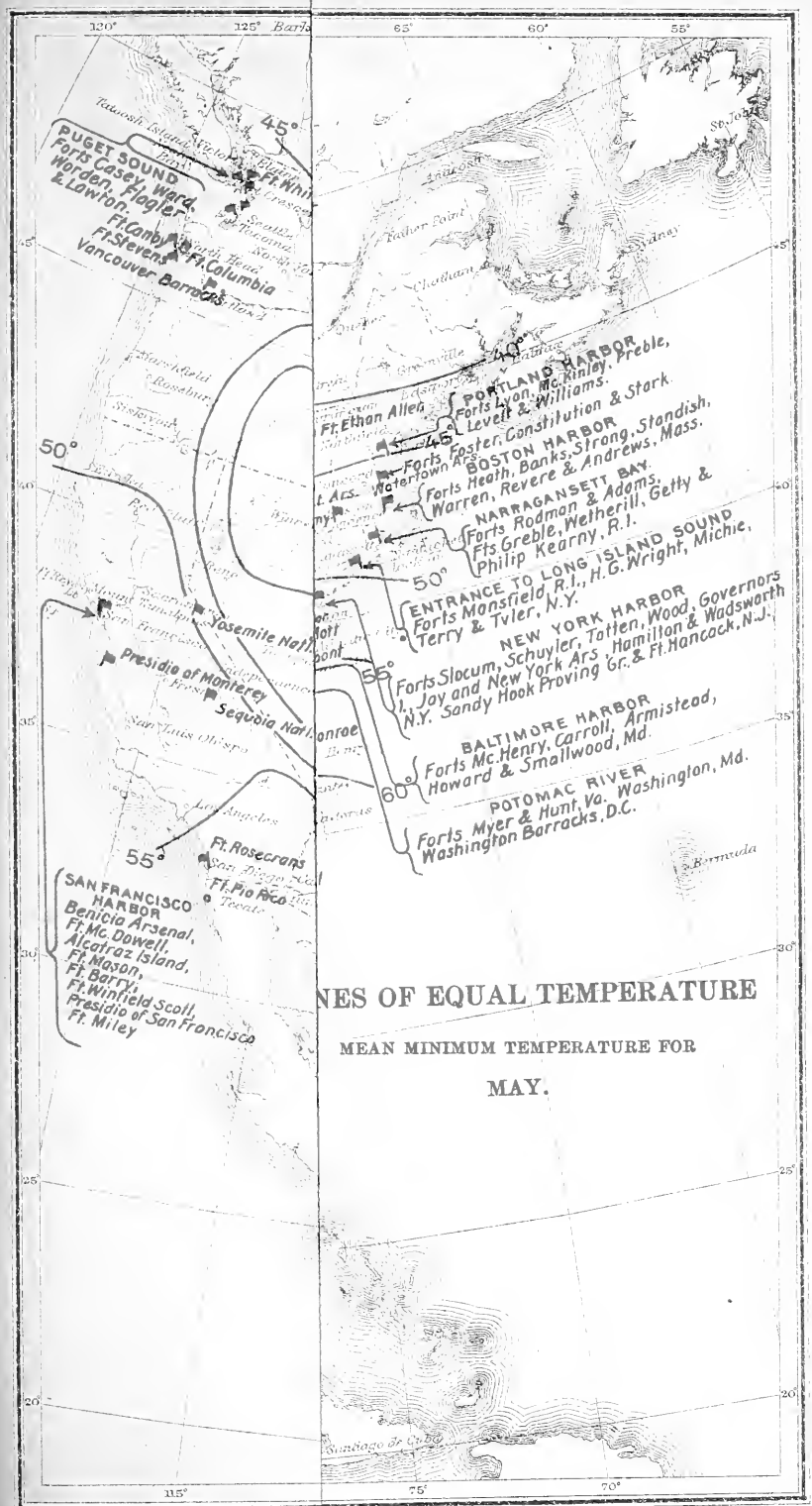


NES OF EQUAL TEMPERATURE

MEAN MINIMUM TEMPERATURE FOR

APRIL.


ZONES OF EQUAL TEMPERATURE
MEAN MINIMUM TEMPERATURE FOR
APRIL.
PUGET SOUND
Forts Casey, Ward, Worden, Flagler & Lawton
Ft Whitman
Ft Geo Wright
Ft Missoula
Ft Walla Walla
Ft Wm Henry Harrison
Ft Keogh Remount Depot
Ft Lincoln
Ft Brady
Ft Yellowstone
Ft Mackenzie
Ft Meade
Ft Snelling
Boise Bks
Ft Robinson
Ft D A Russell
Ft Douglas
Ft Duchesne
Yosemite Natl Park
Presidio of Monterey
Sequoia Natl Park
Ft Logan
Ft Omaha
Ft Des Moines
Ft Sheridan
Rock Island Ars
Ft Crook
Ft Wayne
Ft Leavenworth
Ft Riley
Ft Benj Harrison
Ft Thomas
Front Royal Remount Depot
Jefferson Bks
Whipple Bks
Ft Wingate
Ft Apache
Ft Rosecrans
Ft Mc Rico
Ft Bayard
Ft Huachuca
Ft Bliss
Ft Reno Remount Depot
Ft Sill
Ft Logan H Roots
Hot Springs Army & Navy Hosp
Ft Oglethorpe
Ft Caswell
Ft Mc Pherson
Augusta Ars
Ft Moultrie
Ft Sumter
Ft Pulaski
Ft Screven
Ft Barrancas
Ft Pickens
Ft Mc Rae
Ft Ogden
Ft Morgan
Ft Clark
Jackson Bks
Ft Jackson
Ft St Philip
Ft Travis
Ft San Jacinto
Ft Crockett
Fort Sam Houston
San Antonio Ars
Ft Mc Intosh
Ft De Soto
Ft Dade
Key West Bks
Ft Taylor
Plattsburg Bks
Ft Ethan Allen
Madison Bks
Ft Ontario
Ft Niagara
Watervliet Ars
Springfield Armory
Ft Porter
West Point
Picatinny Ars
Philadelphia Depot
Ft Mott
Ft Dupont
Ft Wool
Ft Monroe
PORTLAND HARBOR
Forts Levett, McKinley, Preble, Lyon, Mc Williams
BOSTON HARBOR
Forts Foster, Constitution & Stark
Forts Heath, Bonhomme Richard, Strong, Standish, Warren, Revere & Andrews, Mass.
NARRAGANSETT BAY
Forts Wetherill, Getty & Greble, Rodman & Adams, Philip Kearny, R I.
ENTRANCE TO LONG ISLAND SOUND
Forts Mansfield, R I., H G Wright, Michie, Terry & Tyler, N Y.
NEW YORK HARBOR
Forts Slocum, Schuyler, Totten, Wood, Governors I., Jay and New York Ars., Hamilton & Wadsworth N.Y. Sandy Hook Proving Gr. & Ft Hancock, N.J.
BALTIMORE HARBOR
Forts Mc Henry, Carroll, Armistead, Howard & Smallwood, Md
POTOMAC RIVER
Forts Myer & Hunt, Va Washington Barracks, D.C.
SAN FRANCISCO HARBOR
Benicia Arsenal, Ft Mc Dowell, Alcatraz Island, Ft Mason, Ft Barry, Ft Winfield Scott, Presidio of San Francisco, Ft Miley
30°
35°
40°
45°
50°
55°
60°
65°
70°

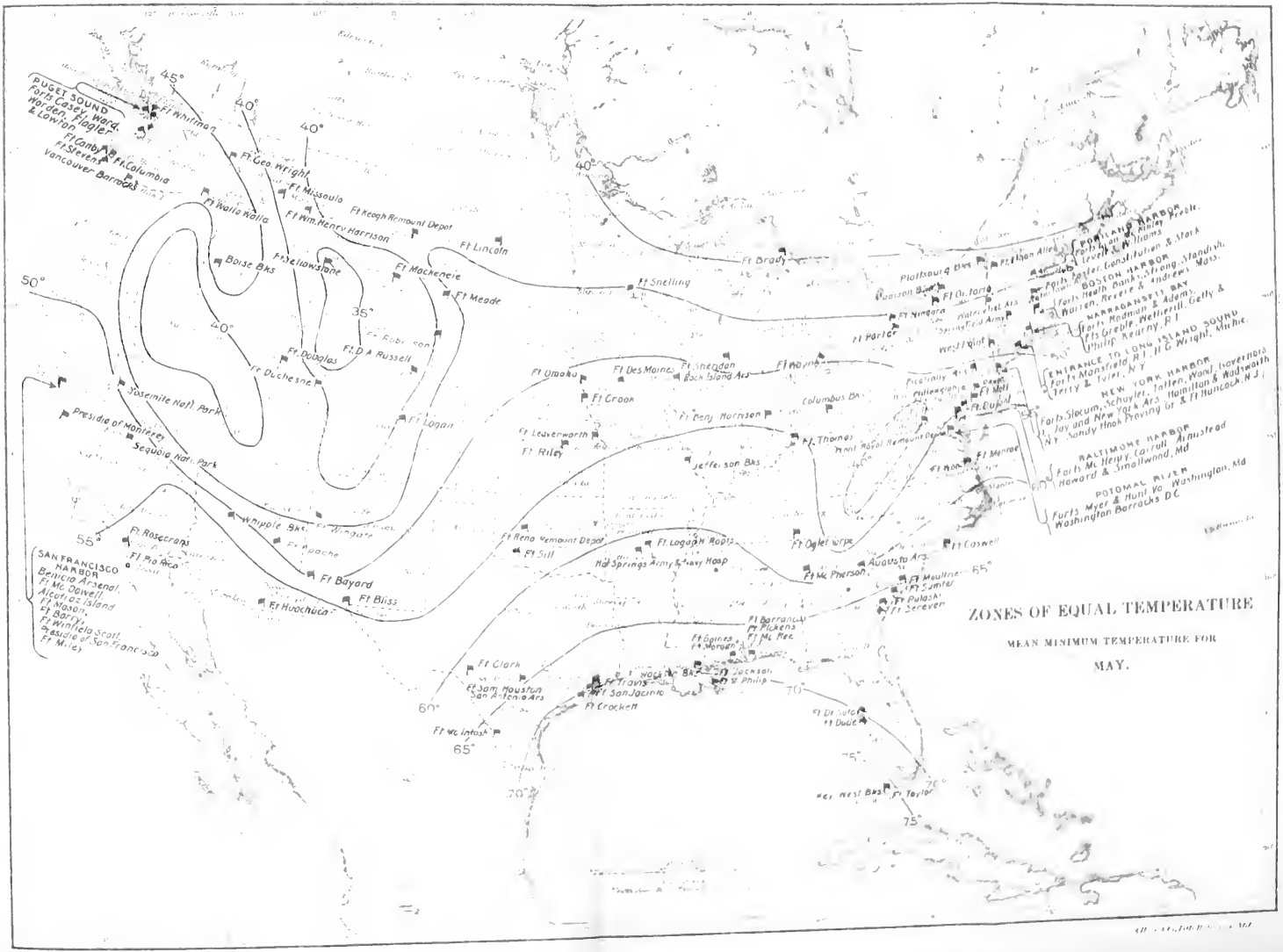


NES OF EQUAL TEMPERATURE

MEAN MINIMUM TEMPERATURE FOR

MAY.

A. Hoen & Co. Lith. Baltimore, Md.


ZONES OF EQUAL TEMPERATURE
MEAN MINIMUM TEMPERATURE FOR
MAY.
PUGET SOUND
Forts Casey, Ward, Worden, Flagler & Lawton
Ft Canby
Ft Stevens
Vancouver Barracks
Ft Columbia
Ft Whitman
Ft Walla Walla
Ft Geo. Wright
Ft Missoula
Ft Wm. Henry Harrison
Ft Keogh
Remount Depot
Ft Lincoln
Boise Bks
Ft Sheridan
Ft Mackenzie
Ft Meade
Ft Robinson
Ft D A Russell
Ft Douglas
Ft Duchesne
Ft Logan
Yosemite Natl. Park
Presidio of Monterey
Sequoia Natl. Park
Whipple Bks
Ft Wingate
Ft Apache
Ft Rosecrans
Ft Rio Vista
SAN FRANCISCO HARBOR
Benicia Arsenal
Ft Mc Dowell
Alcatraz Island
Ft Mason
Ft Barry
Ft Winfield Scott
Presidio of San Francisco
Ft Miley
Ft Bayard
Ft Huachuca
Ft Bliss
Ft Clark
Ft Sam Houston
San Antonio Arsenal
Ft Travis
Ft San Jacinto
Ft Crockett
Ft McIntosh
Ft Reno
Remount Depot
Ft Sill
Hot Springs Army & Navy Hosp
Ft Logan H Roots
Ft Barrancas
Ft Pickens
Ft Mc Rae
Ft Egines
Ft Morgan
Mobile Bay
Ft Jackson
Ft W Philip
Ft Brady
Ft Snelling
Ft Ontario
Ft Niagara
Watervliet Arsenal
Springfield Armory
Plattsburg Bks
Harrison Bks
Ft Porter
West Point
Ft Hamilton
Ft Wadsworth
Ft Columbus
Governors Island
Ft Hancock
Sandy Hook Proving Gr
Ft Monroe
Ft Mc Henry
Ft Mc Pherson
Augusta Arsenal
Ft Oglethorpe
Ft Caswell
Ft Moultrie
Ft Sumter
Ft Pulaski
Ft Screven
Ft Dade
Key West Bks
Ft Taylor
Ft Omaha
Ft Des Moines
Ft Sheridan
Rock Island Arsenal
Ft Hayes
Ft Crook
Ft Leavenworth
Ft Riley
Ft Leavenworth
Ft Thomas
Jefferson Bks
Columbus Bks
Ft Benj Harrison
Ft Thomas
Front Royal Remount Depot
Ft Meade
Ft Howard
Ft Mc Henry
Ft Carroll
Ft Wadsworth
Ft Hamilton
Ft Jay
Ft Schuyler
Ft Slocum
Ft Trumbull
Ft Terry
Ft Totten
Ft Wright
Ft Michie
Ft Greble
Ft Wetherill
Ft Getty
Ft Adams
Ft Kearny
Ft Mansfield
Ft Williams
Ft Preble
Ft Levett
Ft Constitution
Ft Stark
Ft Foster
Ft Heath
Ft Banks
Ft Strong
Ft Standish
Ft Revere
Ft Andrews
Ft Madison
Ft Phoenix
Ft Rodman
Ft Taber
Ft Alden
Ft Phoenix
Ft Revere
Ft Andrews
Ft Strong
Ft Standish
Ft Foster
Ft Heath
Ft Banks
Ft Williams
Ft Preble
Ft Levett
Ft Constitution
Ft Stark
Ft Mansfield
Ft Trumbull
Ft Terry
Ft Totten
Ft Wright
Ft Michie
Ft Greble
Ft Wetherill
Ft Getty
Ft Adams
Ft Kearny
Ft Schuyler
Ft Slocum
Ft Jay
Ft Hamilton
Ft Wadsworth
Ft Carroll
Ft Howard
Ft Mc Henry
Ft Myer
Ft Hunt
Washington Barracks
Washington
Alexandria
Arlington
Mt Vernon
Ft Washington
Ft Foote
Ft Belvoir
Ft Humphreys
Ft Monroe
Ft Eustis
Ft Story
Ft Mc Pherson
Ft Oglethorpe
Augusta Arsenal
Ft Caswell
Ft Moultrie
Ft Sumter
Ft Pulaski
Ft Screven
Ft Dade
Key West Bks
Ft Taylor
Ft Omaha
Ft Des Moines
Ft Sheridan
Rock Island Arsenal
Ft Hayes
Ft Crook
Ft Leavenworth
Ft Riley
Ft Benj Harrison
Ft Thomas
Front Royal Remount Depot
Jefferson Bks
Columbus Bks
Ft Meade
Ft Howard
Ft Mc Henry
Ft Carroll
Ft Wadsworth
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Ft Schuyler
Ft Slocum
Ft Trumbull
Ft Terry
Ft Totten
Ft Wright
Ft Michie
Ft Greble
Ft Wetherill
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Ft Adams
Ft Kearny
Ft Mansfield
Ft Williams
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Ft Levett
Ft Constitution
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Ft Banks
Ft Strong
Ft Standish
Ft Revere
Ft Andrews
Ft Madison
Ft Phoenix
Ft Rodman
Ft Taber
Ft Alden
Ft Phoenix
Ft Revere
Ft Andrews
Ft Strong
Ft Standish
Ft Foster
Ft Heath
Ft Banks
Ft Williams
Ft Preble
Ft Levett
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Ft Mansfield
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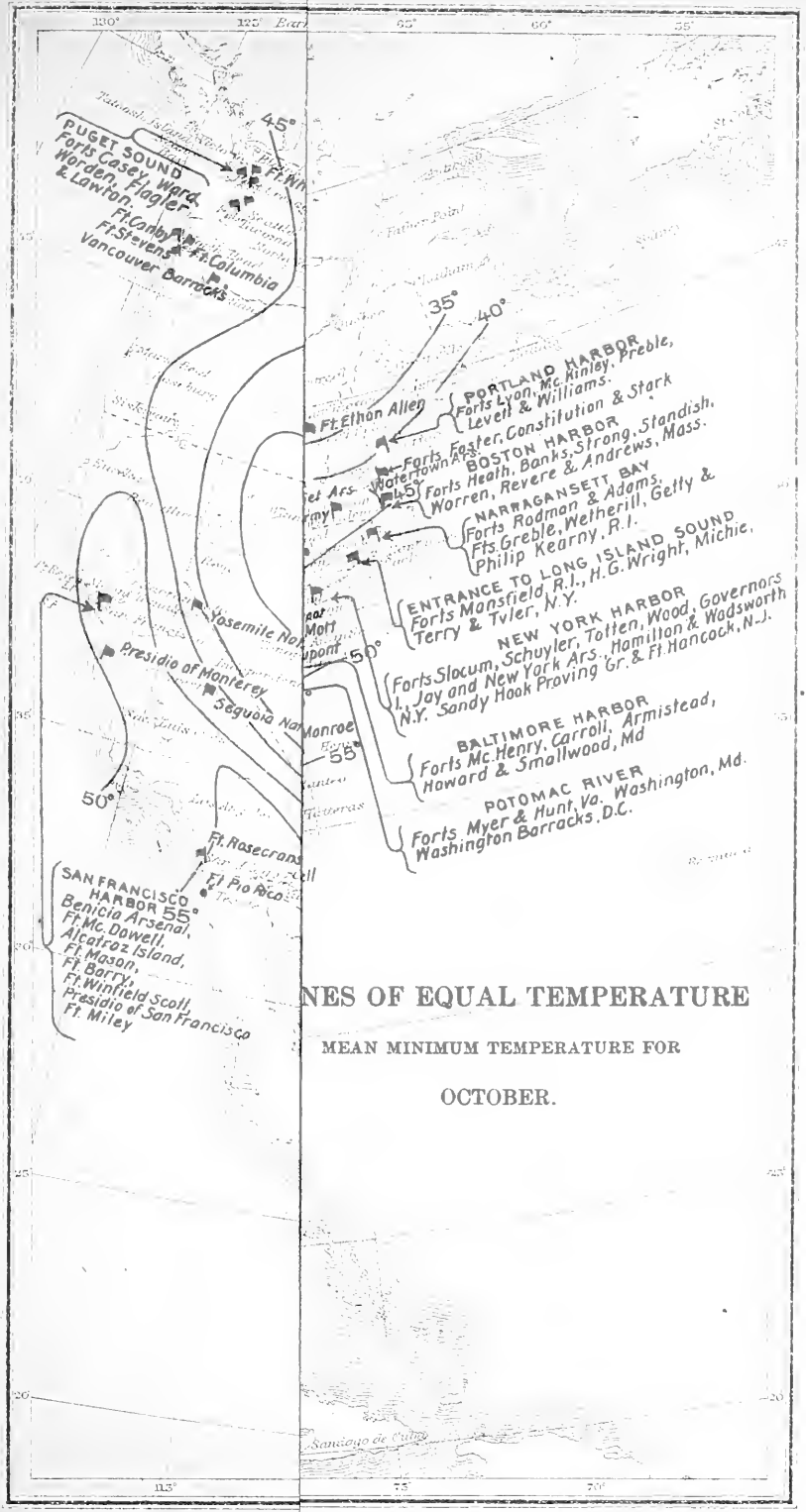
Ft Terry
Ft Totten
Ft Wright
Ft Michie
Ft Greble
Ft Wetherill
Ft Getty
Ft Adams
Ft Kearny
Ft Schuyler
Ft Slocum
Ft Jay
Ft Hamilton
Ft Wadsworth
Ft Carroll
Ft Howard
Ft Mc Henry
Ft Myer
Ft Hunt
Washington Barracks
Washington
Alexandria
Arlington
Mt Vernon
Ft Washington
Ft Foote
Ft Belvoir
Ft Humphreys
Ft Monroe
Ft Eustis
Ft Story
45°
40°
35°
50°
55°
60°
65°
70°
75°
PORTLAND HARBOR
BOSTON HARBOR
NARRAGANSETT BAY
ENTRANCE TO LONG ISLAND SOUND
NEW YORK HARBOR
BALTIMORE HARBOR
POTOMAL RIVER

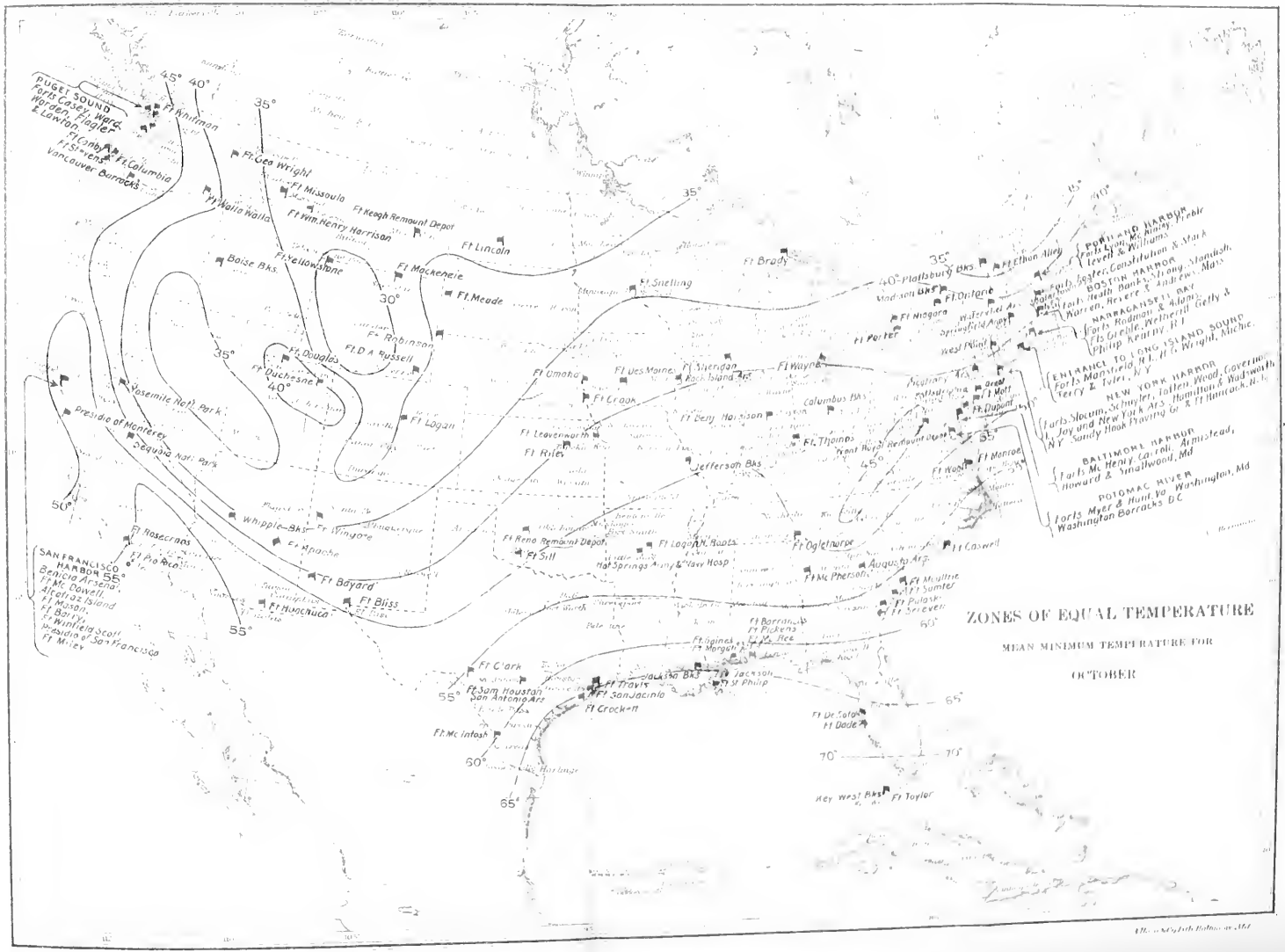


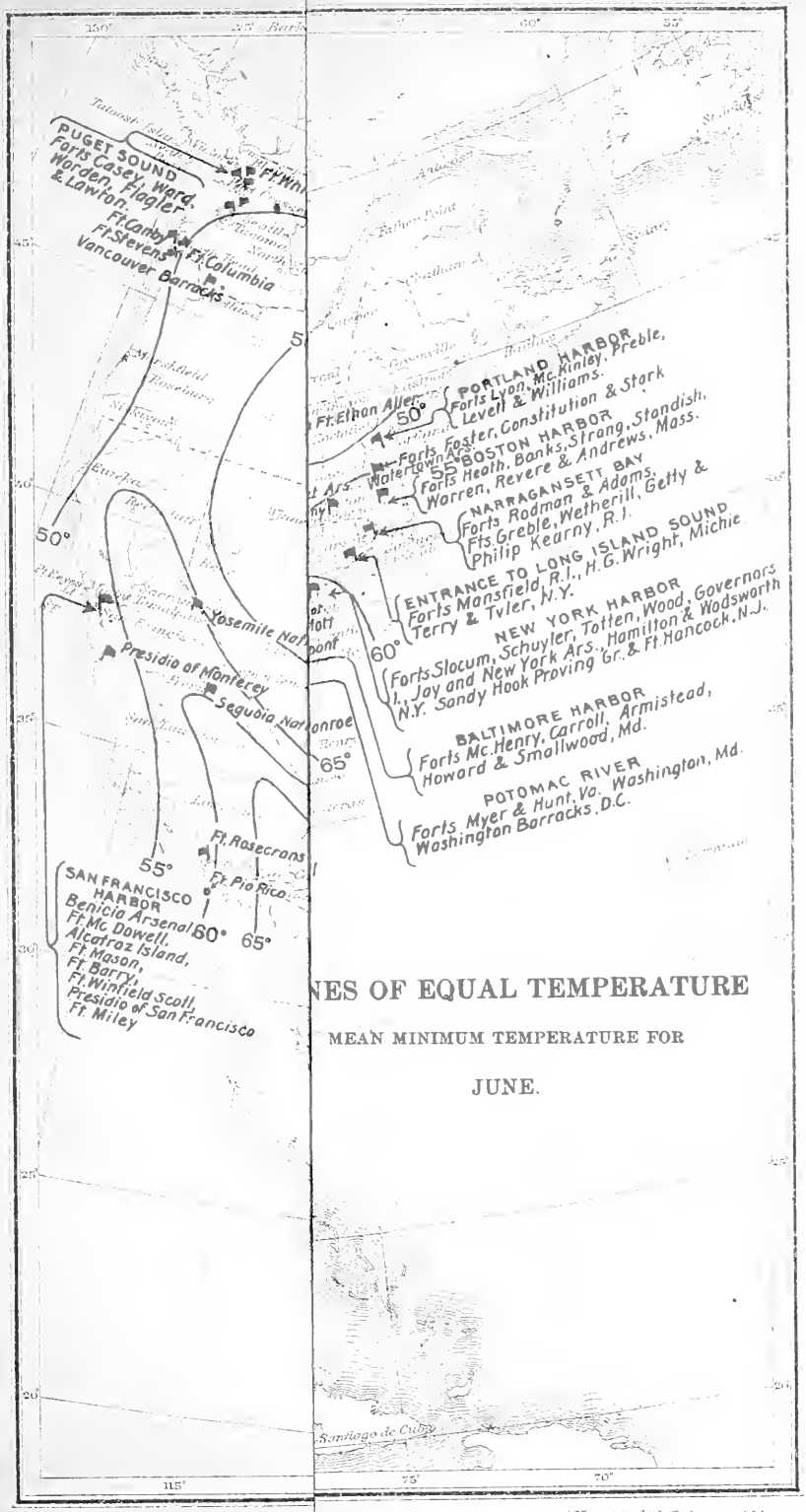
NES OF EQUAL TEMPERATURE

MEAN MINIMUM TEMPERATURE FOR

OCTOBER.

Allman & Co. Lith. Baltimore, Md.


ZONES OF EQUAL TEMPERATURE
MEAN MINIMUM TEMPERATURE FOR
OCTOBER
PUGET SOUND
Forts Casey, Ward
Worden, Flagler
& Lawton
Ft Canby
Ft Stevens
Ft Columbia
Vancouver Barracks
Ft Whitman
Ft Geo Wright
Ft Missoula
Ft Walla Walla
Ft Keogh Remount Depot
Ft Wm Henry Harrison
Ft Lincoln
Boise Brks
Ft Yellowstone
Ft Mackenzie
Ft Meade
Ft Robinson
Ft D A Russell
Ft Douglas
Ft Duchesne
Ft Logan
Yosemite Nat'l Park
Presidio of Monterey
Sequoia Nat'l Park
Ft Rosecrans
Ft Rio Rico
SAN FRANCISCO HARBOR
Benicia Arsenal
Ft Mc Dowell
Ft Mason
Ft Barry
Ft Winfield Scott
Presidio of San Francisco
Ft Miley
Whipple Brks
Ft Wingate
Ft Apache
Ft Bayard
Ft Huachuca
Ft Bliss
Ft Riley
Ft Leavenworth
Ft Omaha
Ft Crook
Ft Des Moines
Ft Sheridan
Rock Island Arsl
Ft Wayne
Ft Brady
Ft Snelling
Jefferson Brks
Ft Reno Remount Depot
Ft Sill
Hot Springs Army & Navy Hosp
Ft Logan H Roots
Ft Oglethorpe
Ft Mc Pherson
Augusta Arp
Ft Caswell
Ft Clark
Ft Travis
Ft Sam Houston
San Antonio Arc
Ft Crockett
Ft Mc Intosh
Ft Jackson
St Philip
Ft De Soto
Ft Dade
Key West Brks
Ft Taylor
Ft Barrancas
Ft Pickens
Ft Barrancas
Ft Morgan
Ft Sumter
Ft Pulaski
Ft Screven
Ft Monroe
Ft Wool
Ft Dupont
Ft Hancock
Ft Hamilton
Ft Wadsworth
Ft Slocum
Ft Schuyler
Ft Totten
Ft Wood
Ft Columbus
Ft Jay and New York Arsl
Sandy Hook Proving Gr
Ft Niagara
Ft Ontario
Ft Porter
Watervliet Arsl
Springfield Armory
West Point
Madison Brks
Plattsburg Brks
Ft Ethan Allen
Columbus Brks
Ft Thomas
Great Falls Remount Depot
Ft Mott
PORTLAND HARBOR
Forts Levett, Mc Kinley, Preble
Fort Constitution & Stark
BOSTON HARBOR
Forts Independence, Standish,
Heath, Banks, Strong, Revere & Andrew, Mass
NARRAGANSETT BAY
Forts Rodman & Adams
Warren, Revere, Wetherill Getty &
Greble, Wetherill, R I
LONG ISLAND SOUND
Forts Terry & Tyler, N Y
Mansfield, R I
Phillip Kearny, R I
Wright, Michie,
ENTRANCE TO LONG ISLAND SOUND
Forts Mansfield, R I
Terry & Tyler, N Y
NEW YORK HARBOR
Forts Slocum, Schuyler, Totten, Wood, Governors
I, Jay and New York Arsl
Hamilton & Wadsworth
Sandy Hook Proving Gr
Ft Hancock, N J
BALTIMORE HARBOR
Forts Mc Henry, Carroll, Armistead,
Howard & Smallwood, Md
POTOMAC RIVER
Forts Myer & Hunt, Va Washington, Md
Washington Barracks D C
35°
40°
45°
50°
55°
60°
65°
70°

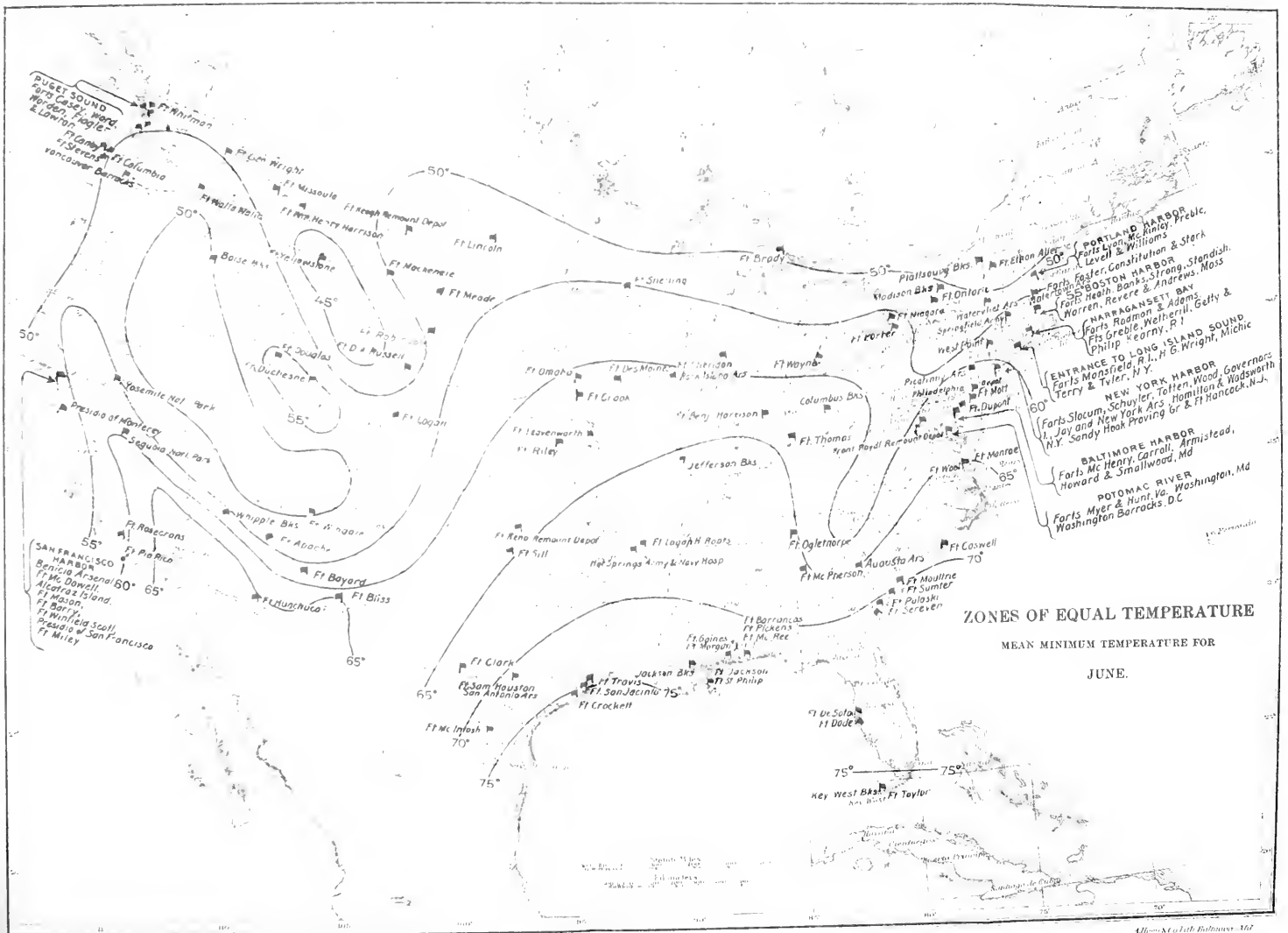


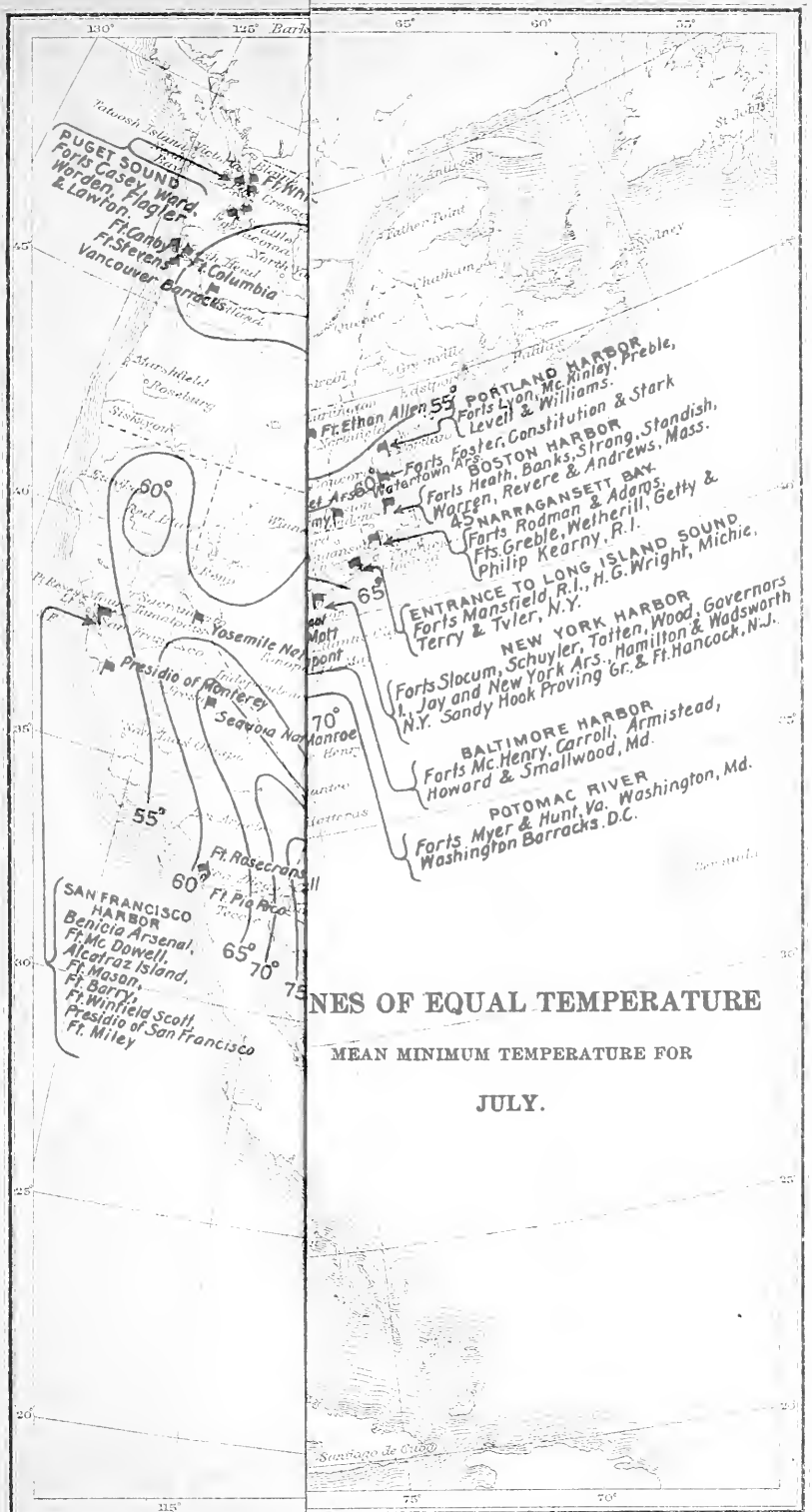
NES OF EQUAL TEMPERATURE

MEAN MINIMUM TEMPERATURE FOR

JUNE.

A. Hoen & Co. Lith. Baltimore, Md.


PUGET SOUND
Forts Casey, Ward, Worden, Flagler & Lawton
Ft Whitman
Ft Lewis
Ft Steilacoom
Ft Columbia
Vancouver Barracks
Ft Walla Walla
Ft Spokane
Ft Wright
Ft Missoula
Ft Wm. Henry Harrison
Ft Keogh Remount Depot
Ft Lincoln
Ft Yellowstone
Ft Mackenzie
Ft Meade
Ft Sheridan
Ft Brady
Ft Ontario
Ft Niagara
Ft Porter
Ft Ethan Allen
Plattsburg Brks
Madison Brks
Watervliet Ars
Springfield Arsl
West Point
PORTLAND HARBOR
Forts Lincoln, Preble, Levett & Williams
BOSTON HARBOR
Forts Winthrop, Foster, Constitution & Stark
Forts Heath, Banks, Strong, Standish, Warren, Revere & Andrews, Moss
NARRAGANSET BAY
Forts Adams, Rodman & Wetherill, Getty & Greble, Kearny, R I
Fts Philip
ENTRANCE TO LONG ISLAND SOUND
Forts Monsfield, R I., H G Wright, Michie Terry & Tyler, N Y.
NEW YORK HARBOR
Forts Slocum, Schuyler, Totten, Wood, Governors I., Jay and New York Ars Hamilton & Wadsworth N.Y. Sandy Hook Proving Gr & Ft Hancock, N.J.
BALTIMORE HARBOR
Forts Mc Henry, Carroll, Armistead, Howard & Smallwood, Md
POTOMAC RIVER
Forts Myer & Hunt, Va. Washington, Md
Washington Barracks, D C
Ft Monroe
Ft Wool
Ft Dupont
Ft Mott
Ft Hancock
Ft Caswell
Ft Fisher
Ft Moultrie
Ft Sumter
Ft Pulaski
Ft Screven
Augusta Ars
Ft Mc Pherson
Ft Ogletnorpe
Columbus Bks
Ft Thomas
Front Royal Remount Depot
Ft Wayne
Ft Omaha
Ft Des Moines
Ft Riley
Ft Leavenworth
Ft Gibson
Ft Arbuckle
Ft Logan
Ft Douglas
Ft Duchesne
Ft D A Russell
Ft Robinson
Ft Yosemite Nat Park
Presidio of Monterey
Sequoia Nat Park
Ft Rosecrans
Ft Mc Rae
SAN FRANCISCO HARBOR
Benicia Arsenal
Ft Mc Dowell
Alcatraz Island
Ft Mason
Ft Barry
Ft Winfield Scott
Presidio of San Francisco
Ft Miley
Whipple Bks
Ft Bayard
Ft Huachuca
Ft Bliss
Ft Reno Remount Depot
Ft Sill
Hot Springs Army & Navy Hosp
Ft Logan H Roots
Jefferson Bks
Ft Barrancas
Ft Pickens
Ft Mc Rae
Ft Clark
Ft Sam Houston
San Antonio Ars
Ft Travis
Ft San Jacinto
Ft Crockett
Galveston Bks
Ft Jackson
Ft St Philip
Ft Mc Intosh
Ft De Soto
Ft Dade
Key West Bks
Ft Taylor
50°
55°
60°
65°
70°
75°
45°
ZONES OF EQUAL TEMPERATURE
MEAN MINIMUM TEMPERATURE FOR
JUNE.

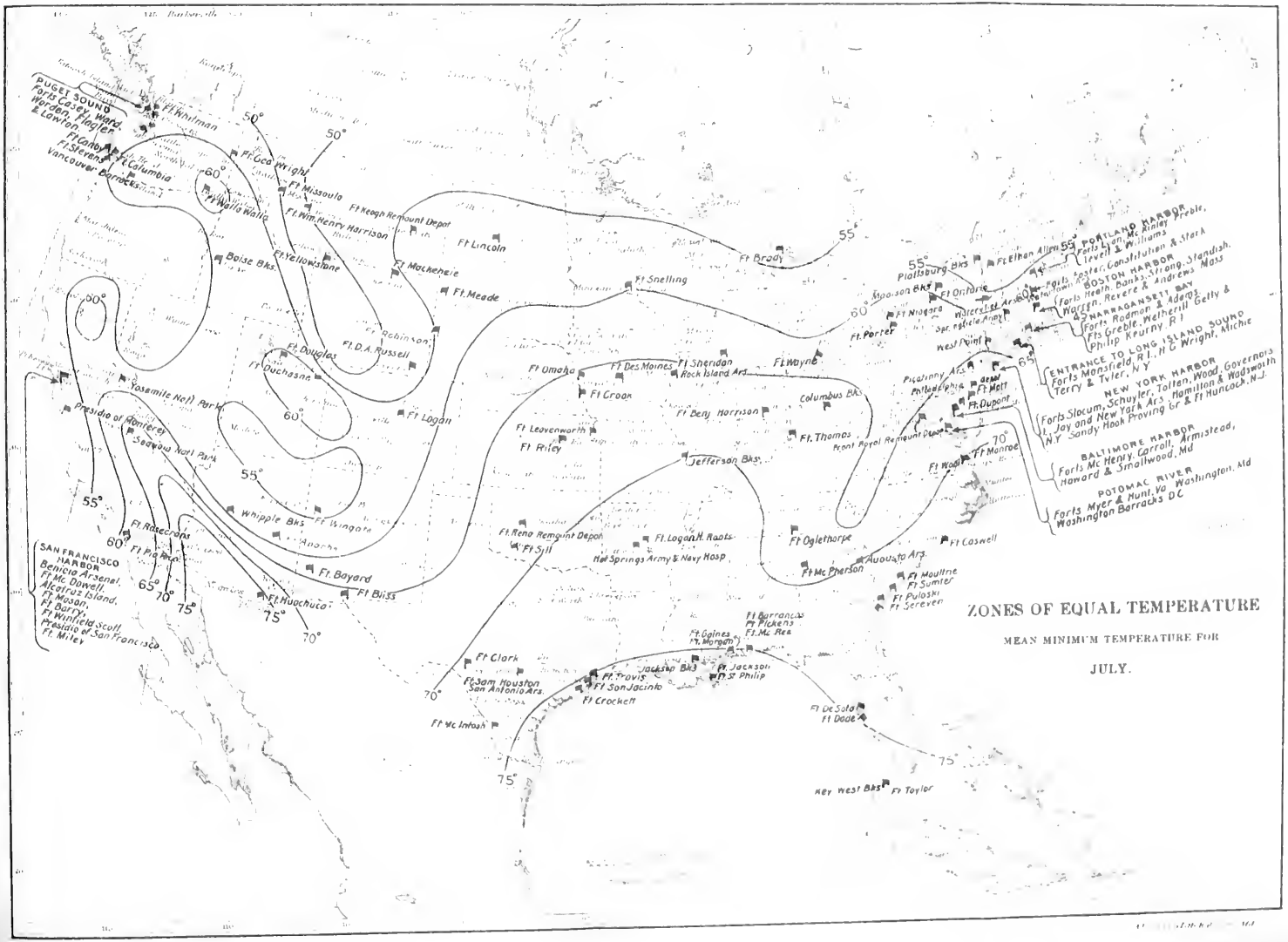


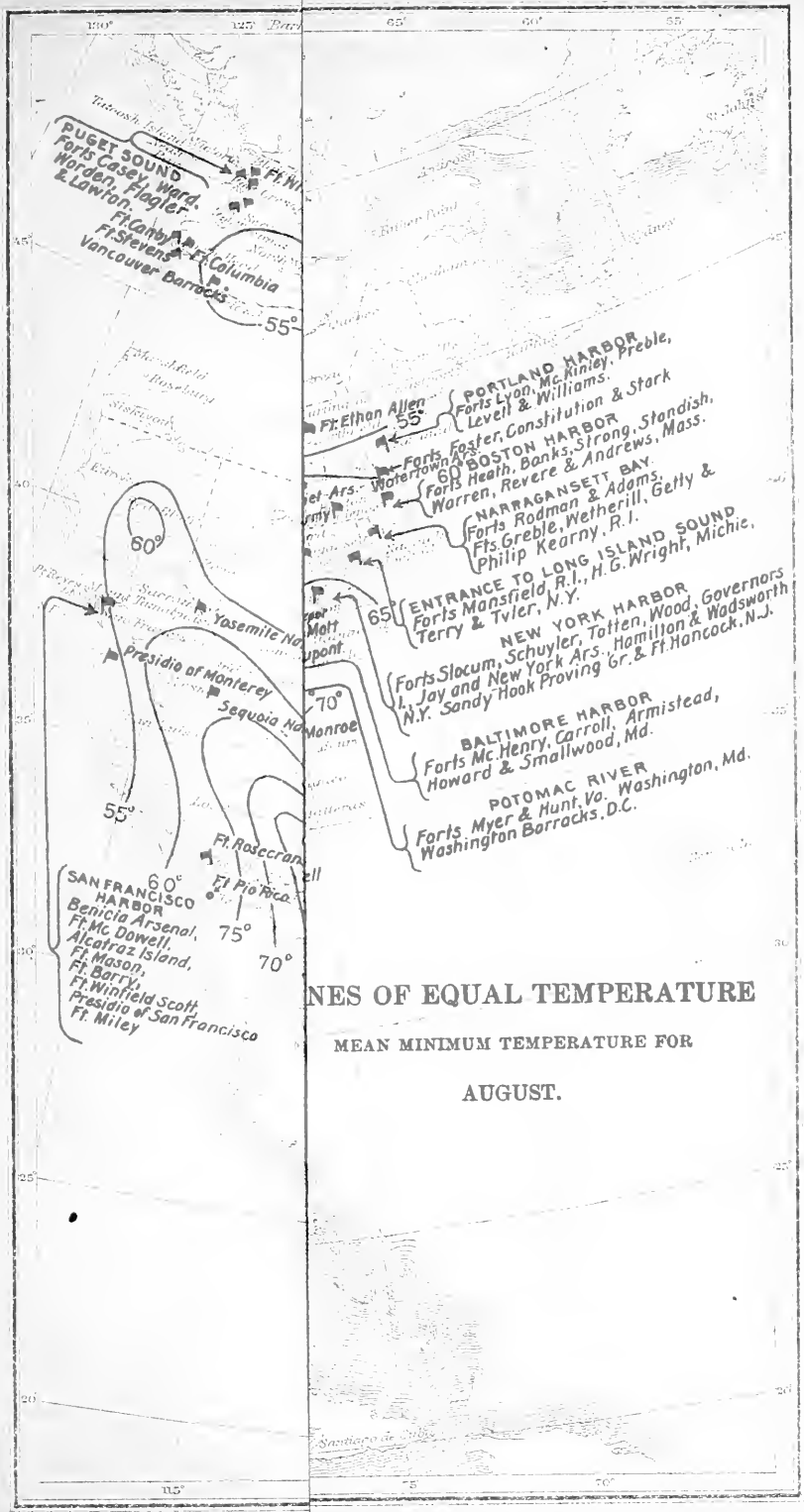
NES OF EQUAL TEMPERATURE

MEAN MINIMUM TEMPERATURE FOR

JULY.

A. Hinen & Co. Lith. Baltimore, Md.


PUGET SOUND
Forts Casey, Ward, Worden, Flagler & Lawton
Ft Whitman
Ft Canby
Ft Columbia
Ft Stevens
Vancouver Barracks
Ft Walla Walla
Ft Geo Wright
Ft Missoula
Ft Wm Henry Harrison
Ft Keogh Remount Depot
Ft Lincoln
Ft Yellowstone
Boise Brks
Ft Mackenzie
Ft Meade
Ft Robinson
Ft D A Russell
Ft Douglas
Ft Duchesne
Ft Logan
Yosemite Natl Park
Presidio of Monterey
Seqouia Natl Park
Ft Rosecrans
Ft Wingate
Whipple Brks
Ft Bayard
Ft Huachuca
Ft Bliss
SAN FRANCISCO HARBOR
Benicia Arsenal
Ft Mc Dowell
Alcatraz Island
Ft Mason
Ft Barry
Ft Winfield Scott
Presidio of San Francisco
Ft Miley
Ft Brady
Ft Snelling
Ft Omaha
Ft Des Moines
Ft Sheridan
Rock Island Arsl
Ft Wayne
Ft Crook
Ft Leavenworth
Ft Riley
Ft Benj Harrison
Columbus Bks
Ft Thomas
Front Royal Remount Depot
Jefferson Bks
Ft Reno Remount Depot
Ft Sill
Ft Logan H Roots
Hot Springs Army & Navy Hosp
Ft Oglethorpe
Ft Mc Pherson
Augusta Arsl
Ft Moultrie
Ft Sumter
Ft Pulaski
Ft Screven
Ft Caswell
Ft Barrancas
Ft Pickens
Ft Mc Rea
Ft Gaines
Ft Morgan
Ft Clark
Ft Sam Houston
San Antonio Arsl
Jackson Brks
Ft Travis
Ft San Jacinto
Ft Crockett
Ft Jackson
Ft St Philip
Ft Mc Intosh
Ft De Soto
Ft Dade
Key West Brks
Ft Taylor
Plattsburg Brks
Ft Ethan Allen
Ft Ontario
Spaulding Brks
Ft Niagara
Watervliet Arsl
Spr'gfield Armory
Ft Porter
West Point
Picatinny Arsl
Philadelphia
Ft Mott
Ft Dupont
Ft Monroe
Ft Wool
PORTLAND HARBOR
Forts Levett, Mc Kinley, Preble, Lowell & Williams
BOSTON HARBOR
Forts Sewall, Constitution & Stark
Forts Heath, Banks, Strong, Standish, Warren, Revere & Andrews Mass
NARRAGANSETT BAY
Forts Rodman & Adams
Forts Greble, Wetherill Getty & Philip Kearny R I
ENTRANCE TO LONG ISLAND SOUND
Forts Mansfield R I, H G Wright, Ritchie
Forts Terry & Tyler, N Y
NEW YORK HARBOR
Forts Slocum, Schuyler, Totten, Wood, Governors I, Jay and New York Arsl, Hamilton & Wadsworth N Y Sandy Hook Proving Gr & Ft Huncock N J
BALTIMORE HARBOR
Forts Mc Henry, Carroll, Armistead, Howard & Smallwood, Md
POTOMAC RIVER
Forts Myer & Hunt, Va Washington, Md
Washington Barracks D C
ZONES OF EQUAL TEMPERATURE
MEAN MINIMUM TEMPERATURE FOR
JULY.

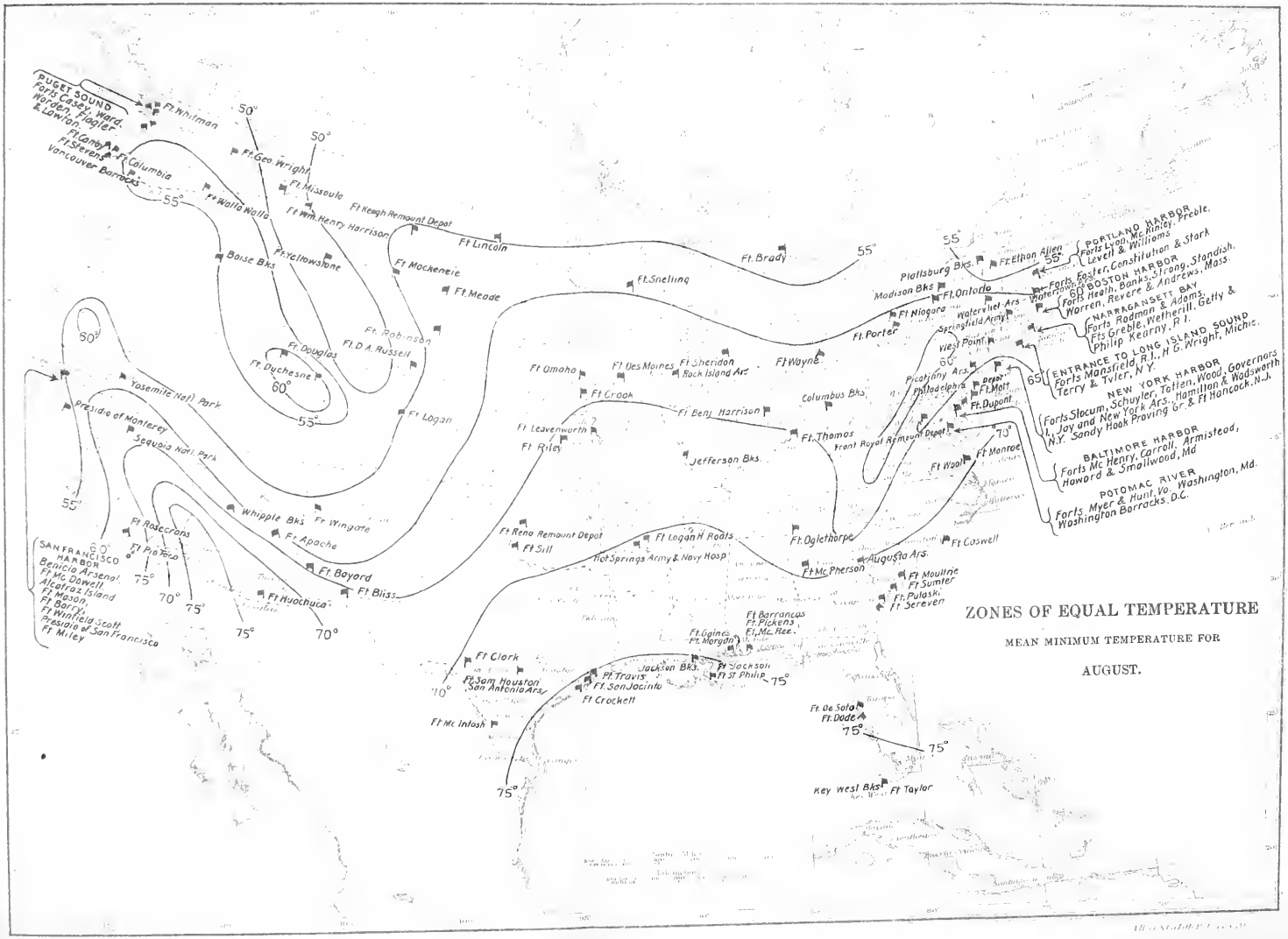


NES OF EQUAL TEMPERATURE

MEAN MINIMUM TEMPERATURE FOR

AUGUST.

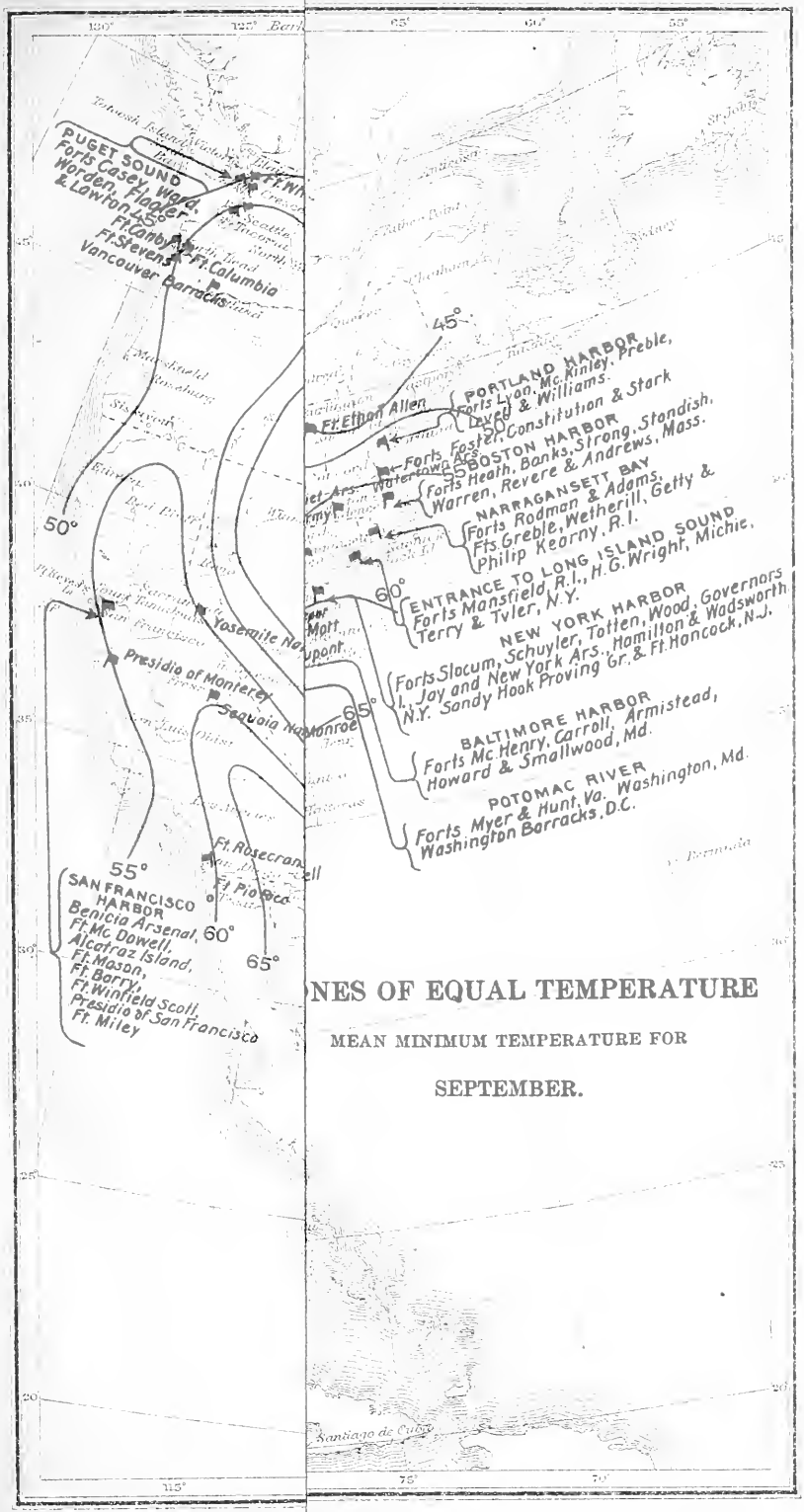
A. Hoen & Co. Lith. Baltimore, Md.



ZONES OF EQUAL TEMPERATURE

MEAN MINIMUM TEMPERATURE FOR

AUGUST.

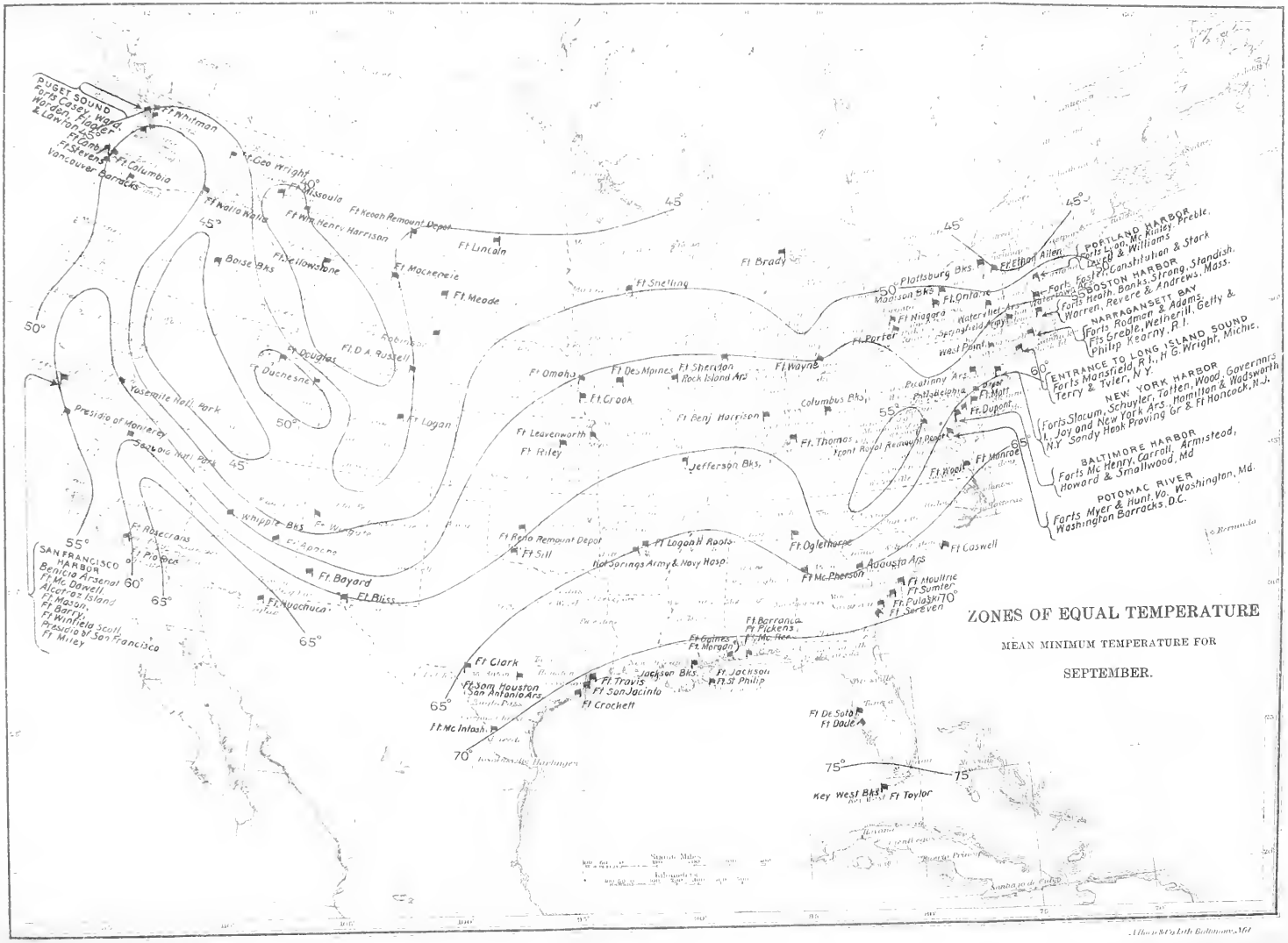


ONES OF EQUAL TEMPERATURE

MEAN MINIMUM TEMPERATURE FOR

SEPTEMBER.

A. Hoen & Co's Lith. Baltimore, Md.


ZONES OF EQUAL TEMPERATURE
MEAN MINIMUM TEMPERATURE FOR
SEPTEMBER.
PUGET SOUND
Forts Casey, Flagler, Worden, Ward, & Lawton
Ft Whitman
Ft Townsend
Ft Steven
Ft Columbia
Vancouver Barracks
Ft Geo Wright
Ft Missoula
Ft Walla Walla
Ft Wm Henry Harrison
Ft Keogh Remount Depot
Ft Lincoln
Boise Brks
Ft Yellowstone
Ft Mackenzie
Ft Meade
Ft Douglas
Ft D A Russell
Ft Duchesne
Yosemite Natl Park
Presidio of Monterey
Sequoia Natl Park
Ft Logan
Ft Rosecrans
Ft Apache
Ft Bayard
El Paso
Ft Huachuca
SAN FRANCISCO HARBOR
Benicia Arsenal
Ft Mc Dowell
Alcatraz Island
Ft Mason
Ft Barry
Ft Winfield Scott
Presidio of San Francisco
Ft Miley
Ft Snelling
Ft Brady
Ft Omaha
Ft Des Moines
Ft Sheridan
Rock Island Arsl
Ft Wayne
Ft Crook
Ft Leavenworth
Ft Riley
Ft Benj Harrison
Jefferson Brks
Whipple Brks
Ft Wingate
Ft Sill
Ft Reno Remount Depot
Hot Springs Army & Navy Hosp
Ft Logan H Roots
Ft Clark
Ft Sam Houston
San Antonio Arsl
Jackson Brks
Ft Travis
Ft San Jacinto
Ft Crockett
Ft Jackson
Ft St Philip
Ft Mc Intosh
Ft Barranca
Ft Pickens
Ft Barrancas
Ft Morgan
Ft Oglethorpe
Ft Mc Pherson
Augusta Arsl
Ft Caswell
Ft Moultrie
Ft Sumter
Ft Pulaski
Ft Screven
Ft De Soto
Ft Dade
Key West Brks
Ft Taylor
Plattsburg Brks
Madison Brks
Ft Ontario
Ft Niagara
Watervliet Arsl
Springfield Army
West Point
Ft Porter
Ft Ethan Allen
PORTLAND HARBOR
Forts Mc Kinley, Preble, Lyon & Williams
Fort Constitution & Stark
BOSTON HARBOR
Fort Foster
Forts Heath, Banks, Strong, Standish, Warren, Revere & Andrews, Mass.
NARRAGANSETT BAY
Forts Rodman & Adams
Fts Greble, Wetherill, Getty & Philip
Kearny, R I.
ENTRANCE TO LONG ISLAND SOUND
Forts Mansfield, R I., H G Wright, Michie, Terry & Tyler, N Y.
NEW YORK HARBOR
Forts Schuyler, Totten, Wood, Governors I, Joy and New York Arsl, Hamilton & Wadsworth
Forts Slocum, N Y Sandy Hook Proving Gr & Ft Hancock, N J.
Ft Monroe
Ft Dupont
Ft Monroe
BALTIMORE HARBOR
Forts Mc Henry, Carroll, Armistead, Howard & Smallwood, Md
POTOMAC RIVER
Forts Myer & Hunt, Va. Washington, Md.
Washington Barracks, D C.
Bermuda
Statute Miles